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NATIONAL DAM INSPECTION PROGRAM. LAKE LEHIGH DAM (NDI ID NUMBER--ETC(U)
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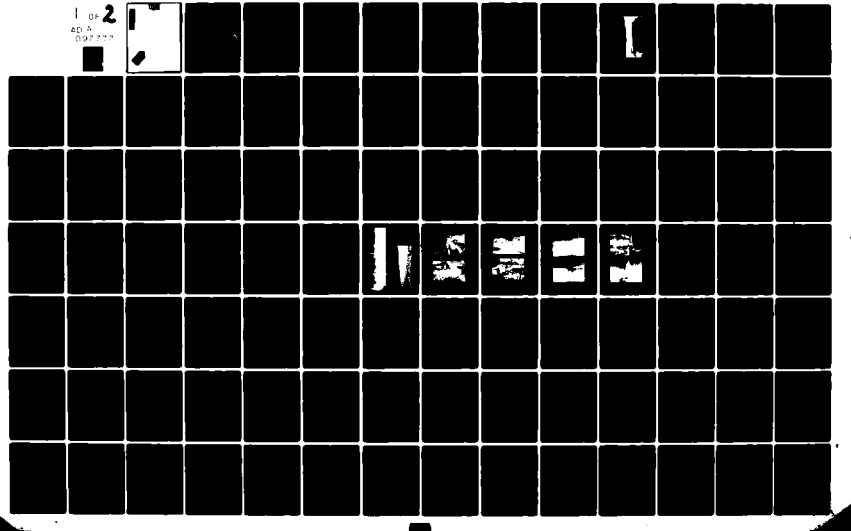

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DELAWARE RIVER BASIN

LEHIGH RIVER, WAYNE AND LACKAWANNA COUNTIES

PENNSYLVANIA

(6) National Dam Inspection Program.

LAKE LEHIGH DAM

(NDI ID Number PA-00151
DER ID Number 64-51)

~~D. M. BRANDON, JR., D. C. BRANDON,~~
AND ~~D. L. BRANDON~~

Delaware River Basin
Lehigh River, Wayne and Lackawanna
Counties, Pennsylvania.

PHASE I INSPECTION REPORT.

NATIONAL DAM INSPECTION PROGRAM

12/18

Prepared by

GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
P.O. Box 1963
Harrisburg, Pennsylvania 17105

For

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

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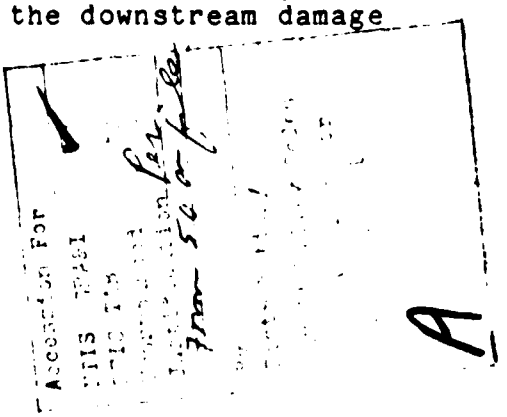
PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.



LAKE LEHIGH DAM

NDI ID No. PA-00151, DER ID No. 64-51

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

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APPENDICES

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

Name of Dam:	Lake Lehigh Dam NDI ID No. PA-00151 DER ID No. 64-51
Size:	Small (10 feet high; 163 acre-feet)
Hazard Classification:	High
Owner:	D. M. Brandon, Jr., D. C. Brandon, and D. L. Brandon 1710 Leon-Simon Drive New Orleans, LA 70122
State Located:	Pennsylvania
County Located:	Wayne and Lackawanna
Stream:	Lehigh River
Dates of Inspection:	29 October 1980 6 November 1980

Based on visual inspection, available records, and engineering calculations, Lake Lehigh Dam is considered to be in poor condition and is judged to be unsafe, nonemergency. Based on the size and hazard classification of the dam, the recommended Spillway Design Flood (SDF) varies between 1/2 the Probable Maximum Flood (PMF) and the PMF. Considering the size of dam and reservoir, the 1/2 PMF is selected as the SDF. Based on conditions at the time of the inspection, the spillway will pass only two percent of the PMF without overtopping the dam. The spillway capacity is rated as seriously inadequate. It is judged that the dam could not withstand the depth and duration of overtopping that would occur for the 1/2 PMF. A failure of the dam will increase the hazard to loss of life at several homes located downstream.

The spillway timbers are badly deteriorated. Seepage is extensive and is estimated at 500 gallons per minute (gpm). The seepage is concentrated at the principal spillway abutments and has probably contributed to settlement of the embankment. The dam shows numerous signs of distress.

There are no means of drawing down the reservoir since the outlet works facilities are nonfunctional.

Representatives of the Baltimore District, Corps of Engineers and Pennsylvania Department of Environmental Resources visited the dam on 6 November 1980. The dam was, at that time, assessed as unsafe, emergency by the Baltimore District, Corps of Engineers. On 13 November 1980, the District Engineer of the Baltimore District, Corps of Engineers sent a letter to the Governor of the Commonwealth informing him of the unsafe conditions at the dam and recommending that the dam be breached. Since that time the Owner has taken the following measures in order to reduce the hazards associated with the dam:

(1) Engaged an engineer to develop plans for rehabilitation of the structure.

(2) Developed an emergency operation and warning plan.

(3) Breached a portion of the dam which has lowered the pool level approximately three feet.

In view of the recent actions taken by the Owner, Lake Lehigh Dam has been re-assessed as unsafe-nonemergency.

The following measures, listed in approximate order of priority, are recommended to be immediately undertaken by the Owner:

(1) Continue to maintain the reservoir at its present (lowered) pool level. The breach in the dam should be of sufficient size that it is not possible to impound any significant quantity of water behind the dam during a flood.

(2) Continue developing plans to repair or remove the dam and its appurtenant structures. If the Owner chooses to repair the dam, he should perform additional studies to more accurately ascertain the spillway capacity required for Lake Lehigh Dam as well as the nature and extent of mitigation measures required to make the

spillway hydraulically adequate. Appropriate action should be taken as required. In addition, repairs to the dam should address the various deficiencies noted in this report.

All investigations, studies, designs, and inspection of construction should be performed by a professional engineer experienced in the design and construction of dams.

In addition, the Owner should institute the following operational procedures:

(1) During periods of unusually heavy rains, provide round-the-clock surveillance of the dam.

(2) When warnings of a major storm are given by the National Weather Service, the Owner should activate his emergency operation and warning plan.

If the Owner chooses to repair the dam, he should institute the following maintenance procedures:

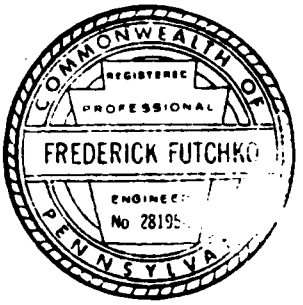
(1) Institute an inspection program such that the dam is inspected on a regular basis. As presently required by the Commonwealth, the inspection program should include a formal annual inspection by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

(2) Institute a maintenance program and develop a formal maintenance manual so that all features of the dam are properly maintained.

LAKE LEHIGH DAM

Submitted by:

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.



FREDERICK FUTCHKO
Project Manager, Dam Section

Date: 9 February 1981

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF
ENGINEERS

JAMES W. PECK
Colonel, Corps of Engineers
District Engineer

Date: 4 MARCH 81

LAKE LEHIGH DAM

Overview

LAKE LEHIGH DAM

NDI ID No. PA-00151, DER ID No. 64-51

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

SECTION 1

PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Lake Lehigh Dam is an earth/rockfill and dry stone masonry structure with a rock-filled timber crib spillway located near the center of the embankment and a vegetated spillway at the right abutment. The dam is also known as West End Pond Dam. It is 10 feet high and approximately 320 feet long, including the 88-foot long principal spillway and 20-foot long emergency spillway. The downstream side of the dam is formed by a vertical dry stone masonry wall. The upstream slope of the dam is surfaced with riprap. A double row of two-inch plank sheeting was placed vertically at the upstream crest of the dam. The sheeting reportedly extended from the foundation to the top of the dam.

The 88-foot long principal spillway, located near the center of the dam, is a rock-filled timber crib founded on gravel. The timbers were extended 15 feet into the embankment on either side of the spillway. The upstream side of the spillway originally had a double row of two-inch plank sheeting similar to that placed along the crest of the embankment portions of the dam. Although

the original spillway was completely lined with planks, the crest of the existing spillway is now surfaced with stone and small rock. The maximum base width of the spillway was originally reported to be 24 feet. The remains of a plank-lined flume with a low-level corrugated metal outlet pipe is located at the left end of the spillway. It is now backfilled with soil and/or rock and is, therefore, nonfunctional.

The emergency spillway is a 20-foot wide vegetated channel which curves around the right end of the dam. The crest of the spillway, however, is approximately 0.3 foot above the low top of dam.

b. Location. Lake Lehigh Dam is located on the headwaters of the Lehigh River in Lehigh Township, Wayne and Lackawanna Counties, approximately one-half mile northwest of Gouldsboro, Pennsylvania. The dam is shown on USGS Quadrangle, Tobyhanna, Pennsylvania at latitude N 41° 14.9' and longitude W 75° 28.0'. A location map is shown on Plate E-1.

c. Size Classification. Small (10 feet high, 163 acre-feet).

d. Hazard Classification. Downstream conditions indicate that a high hazard classification is warranted for Lake Lehigh Dam (Paragraphs 3.1g and 5.1c).

e. Ownership. D. M. Brandon, Jr., D. L. Brandon, D. C. Brandon, 1710 Leon-Simon Drive, New Orleans, LA 70122.

f. Purpose of Dam. Recreation.

g. Design and Construction History. Very little information is available concerning the design and construction of Lake Lehigh Dam. The dam was constructed for the Lehigh and Lackawanna Ice Company in 1900 under the supervision of W. L. Harvey, Civil Engineer. Mr. Harvey was founder of the Lehigh and Lackawanna Ice Company. Although several modifications have been made to the structure during its lifetime, none of these changes have been documented. They include the addition of the emergency spillway at the right abutment, addition of a low-level outlet pipe in the wooden flume, and addition of earthfill over the rockfill embankment.

h. Normal Operational Procedure. The reservoir level is usually maintained at, or near, the principal

spillway crest. Excess inflows to the reservoir are discharged through the spillway. No operating equipment is located at the damsite.

1.3 Pertinent Data.

a.	Drainage Area. (square miles)	15.7
b.	Discharge at Damsite. (cfs.)	
	Maximum known flood	August 1955 Discharge Unknown.
	Spillway capacity at maximum pool (Elev. 1873.7 feet)	160
c.	Elevation. (feet above msl.)	
	Top of dam	1873.7
	Maximum pool	1873.7
	Emergency spillway	1874.0
	Normal pool (principal spillway crest)	1873.0
	Streambed at toe of dam	1864.0
d.	Reservoir Length. (miles)	
	Normal pool	0.70
	Maximum pool	0.70
e.	Storage. (acre-feet)	
	Normal pool	132
	Maximum pool	163
f.	Reservoir Surface. (acres)	
	Normal pool	44
	Maximum pool	45
g.	Dam.	
	Type	Earth/ rockfill with vertical dry stone masonry wall on down-stream side

g.	Dam. (Continued)	
	Length (feet)	320
	Height (feet)	10
	Top Width (feet)	20
	Side Slopes	
	Upstream Downstream	1V on 4.5H Vertical
	Zoning	Unknown
	Cut-off	None
	Grout Curtain	Unknown
h.	Diversion and Regulating Tunnel.	None
i.	Principal Spillway.	
	Type	Rock-filled timber crib
	Length of weir (feet)	88
	Crest Elevation (feet)	1873.0
	Upstream Channel	Reservoir
	Downstream Channel	Lehigh River
j.	Emergency Spillway.	
	Type	Vegetated channel
	Length of control section (feet)	20
	Crest Elevation	1874.0

j. Emergency Spillway. (Continued)

Upstream channel	Vegetated trapezoidal channel
Downstream channel	Vegetated trapezoidal channel

k. Regulating Outlets. Non-functional

SECTION 2

ENGINEERING DATA

2.1 Design.

a. Data Available. There are no design data available for Lake Lehigh Dam.

b. Design Features. The project is described in Paragraph 1.2a. The various features of the dam are shown on the photographs in Appendix C and on Plate E-2 in Appendix E.

c. Design Considerations. The design of the dam cannot be adequately assessed from available information.

2.2 Construction.

a. Data Available. There are no construction data available for Lake Lehigh Dam.

b. Construction Considerations. The construction of the dam cannot be assessed from available information.

2.3 Operation. There are no formal records of operation. Records of inspections performed by the Commonwealth are available for the period from 1915 to 1965. A summary of these inspections is included in Appendix A.

2.4 Evaluation.

a. Availability. Engineering data were provided by the Bureau of Dams and Waterway Management, Department of Environmental Resources, Commonwealth of Pennsylvania (PennDER).

b. Adequacy. The type and amount of design data and other engineering information are limited. The assessment of the dam must, therefore, be based on the combination of available data, visual inspection, performance history, and hydrologic and hydraulic assumptions.

c. Validity. There is no reason to question the validity of the available data.

SECTION 3

VISUAL INSPECTION

3.1 Findings.

a. General. The overall condition of the dam is poor. Noteworthy deficiencies observed are described in the following paragraphs. The complete visual inspection checklist and field sketch are given in Appendix B.

The reservoir pool was approximately 1.4 feet below the spillway crest at the time of the inspection which was performed on 29 October 1980. A follow-up inspection was performed on 6 November 1980 by representatives from the Baltimore District Corps of Engineers, Pennsylvania Department of Environmental Resources, and Gannett Fleming Corddry and Carpenter, Inc.

b. Embankment. The crest, upstream slope, and downstream toe of the dam are partially overgrown with brush and small trees ranging in size up to six inches in diameter. Low areas were observed on the crest of the dam adjacent to and at both ends of the principal spillway. Each low area is approximately 80 to 100 square feet in size and 12 to 18 inches lower than the remainder of the embankment. Concentrated seepage was observed at the toe of the dam at both locations. A slight drawdown of the water surface was observed at the upstream side of the dam to the right of the spillway where the seepage entered the embankment. The flow could be heard rushing through the embankment at both ends of the spillway. It is possible that this seepage is causing internal erosion of the dam which could be responsible for the low areas. The low areas may also have been caused by overtopping of the dam during high pool levels. The total seepage from the dam was estimated at 500 gallons per minute (gpm). A significant portion of this is probably flowing through or under the principal spillway. The toe of the spillway could not be observed as it was submerged.

Two small depressions were also observed on the crest of the dam to the left of the spillway, both approximately two feet in diameter and six to twelve inches deep. The cause of the depressions could not be readily determined, although they may be the result of the upper layer of soil settling into the lower rockfill layer which formed the original embankment. A larger depression 20 feet long, 3 feet wide and 18 inches deep was found

along the downstream edge of the dam crest to the right of the spillway. Depressions, or voids, were also observed along the upstream edge of the embankment crest. Two such depressions about ten feet long, two feet wide and 12 to 18 inches deep, may be the result of the void created by the deteriorated wood sheeting along the edge of the crest. A small sloughed area about four feet in diameter and two feet deep is located just to the left of the wooden flume on the downstream edge of the crest.

The upstream slope of the dam is surfaced with dumped rock and is generally in fair condition, although the rock is sparse in a few places. The vertical dry stone masonry wall on the downstream side of the dam is in fair condition. Some rock has been dumped at the toe of the wall along the right end of the dam.

c. Principal Spillway. The timbers forming the spillway are very badly deteriorated. This is probably the result of continuous wetting and drying during the 80-year life of the structure. The crest of the spillway has been altered substantially from its original configuration. This alteration was probably performed in an attempt to delay deterioration of the structure. The crest is now surfaced with stone and small rock and is contained on the downstream edge by wooden planks and corrugated sheet metal. The vertical wooden planks at each end of the spillway are also badly deteriorated which tends to create voids within the dam. Although the downstream toe of the structure was submerged, it is estimated that a substantial percentage of the total seepage from the dam is flowing under or through the spillway. Overall the spillway is in very poor condition.

d. Emergency Spillway. As shown on the top of dam profile (Plate E-2), the spillway crest is higher than the minimum top of dam elevation which renders the spillway nonfunctional. Brush and small trees are growing in the spillway approach and discharge channels.

e. Outlet Works. The outlet works structure has been backfilled with soil and rock and is, therefore, completely nonfunctional. The wooden planks which once formed the flume are badly deteriorated and as previously mentioned tend to create voids in the dam.

f. Reservoir Area. The Lake Lehigh watershed which is predominantly wooded has six other dams and several small ponds located within its boundaries. The Lake extends to the downstream toe of Johnson Pond Dam which is located approximately 0.7 mile upstream.

g. Downstream Channel. Five homes are located in low-lying areas approximately one mile downstream from the dam. The lowest of these is approximately seven feet above the streambed. Because of the configuration of the stream valley in this area, it is estimated that at least two of the residences would be flooded in the event of a dam failure.

SECTION 4

OPERATIONAL PROCEDURES

4.1 Procedure. During normal flow conditions the reservoir pool is maintained at or slightly above the principal spillway crest. During wet periods, excess inflows are discharged through the principal spillway. The emergency spillway, as indicated in Section 3, is essentially nonfunctional. There are no functional outlet works facilities.

4.2 Maintenance of Dam. There are no established procedures for maintenance of the dam. Although repairs were made regularly prior to 1965, very little maintenance has been performed during recent years. This is evidenced by the current condition of the dam and its appurtenant structures.

4.3 Maintenance of Operating Facilities. There are no functional outlet works facilities or operating equipment at the dam.

4.4 Warning Systems in Effect. No emergency operation and warning system has been established for the dam.

4.5 Evaluation of Operational Adequacy. The maintenance of the embankment and spillways is very poor. The outlet works could not be made functional without completely reconstructing it. The lack of a periodic inspection program has allowed potentially hazardous conditions to go unobserved.

SECTION 5

HYDROLOGY AND HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. There are no design data for the spillway structures. According to a report by the Commonwealth of Pennsylvania, dated 14 July 1915, the spillway capacity, calculated at 130 cfs, was considered to be grossly inadequate. It also stated, however, that the entire structure could be overtopped without failing.

b. Experience Data. The probable flood of record at the site is the flood of August 1955. It is reported that Lower Klondike Dam, just upstream from Lake Lehigh, was overtopped and breached during this storm. No record of pool levels or spillway discharges are available for Lake Lehigh Dam.

c. Visual Observations.

(1) General. The visual inspection of Lake Lehigh Dam, described in Section 3, resulted in a number of observations relevant to hydrology and hydraulics. These observations are evaluated herein for the various features.

(2) Embankment. The embankment has settled on both sides of the principal spillway. This settlement has reduced the capacity of the spillway and has also rendered the emergency spillway useless since the dam would be overtopped before the emergency spillway would be activated.

(3) Appurtenant Structures. As mentioned previously, the emergency spillway is considered nonfunctional. The outlet works facilities are also nonfunctional.

(4) Reservoir Area. No conditions were observed in the reservoir area that are considered to present a hazard to the dam. A small road bridge is located at the upper end of the lake; however, it is not expected to substantially attenuate inflows to Lake Lehigh.

(5) Downstream Conditions. No conditions that would present a hazard to the dam were observed

downstream. Several homes are located in low-lying areas approximately one mile downstream from the dam. It is probable that substantial damage and possibly loss of life could occur if a failure of the dam were to occur. This condition indicates that a high hazard classification is warranted for Lake Lehigh Dam.

(6) Watershed Area. Six other dams are located in the Lake Lehigh watershed. Together, these structures have a significant storage capacity and were taken into consideration in the hydrologic and hydraulic analysis. Failure of any one of several of these dams could increase the potential for an overtopping failure of Lake Lehigh Dam.

d. Overtopping Potential.

(1) Spillway Design Flood. According to the criteria established by the Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (small) and hazard potential (high) of Lake Lehigh Dam is between one-half of the Probable Maximum Flood (1/2 PMF) and the PMF. Since the dam and reservoir are on the low end of the small size category, the 1/2 PMF is selected as the SDF for Lake Lehigh Dam. The watershed was modeled with the U.S. Army Corps of Engineers' HEC-1DB computer program. A description of this computer model is included in Appendix D. The assessment of the dam is based on existing conditions; the effects of future development not being considered.

(2) Summary of Results. Pertinent results are tabulated at the end of Appendix D. The analysis reveals that Lake Lehigh Dam can pass approximately two percent of the PMF before overtopping of the dam occurs.

(3) Spillway Adequacy. The criteria used to evaluate the spillway adequacy are described in Appendix D. Since the dam could not pass the 1/2 PMF and was considered to fail during storms as small as 5 percent of the PMF, a breach analysis was performed to ascertain the impact of the failure on the downstream area. The conditions contributing to failure of the dam, as well as its failure mode, are included in Appendix D. It was found that failure of the dam during 5 percent of the PMF would cause water levels at the damage center to rise 5.5 feet above the levels that would exist if the dam were not to fail. This represents an increased hazard for loss of life and, accordingly, the spillway capacity of Lake Lehigh Dam is rated as seriously inadequate.

SECTION 6

STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of Lake Lehigh Dam, described in Section 3, resulted in a number of observations relevant to structural stability. These observations are evaluated herein for the various features.

(2) Embankment. The concentrated seepage located at both ends of the principal spillway is a condition which can adversely affect the stability of Lake Lehigh Dam. The seepage is of particular concern because of the rotted wooden planks at both ends of the principal spillway which tend to cause channels through the dam leading to a progressively worse condition. The depressions on the crest of the dam at the ends of the principal spillway are possible indicators of internal embankment erosion which could adversely affect the embankment stability.

The depressions observed on the crest of the dam are also signs of embankment instability. Although the exact cause of these depressions is unknown, it is believed that they are caused by migration of soil particles near the top of the embankment into voids within the embankment. The growth of trees and brush on the dam is undesirable. Root systems can loosen embankment material and eventually create paths along which seepage and piping (internal erosion) might occur. The small sloughed area adjacent to the wooden flume, although not considered serious at this time, can develop into a problem if allowed to go unchecked.

(3) Appurtenant Structures. The deteriorated timbers of the principal spillway create significant concern as to the stability of the structure. It is estimated that the existing spillway would not be able to resist scouring caused by ice or large overflows from the reservoir.

The condition of the outlet works is also questionable. The wood planking forming the structure was not removed prior to backfilling. As the planks deteriorate, voids are created in the dam through which seepage and piping can occur.

b. Design and Construction Data. The available design and construction data are inadequate for use in assessing the stability of Lake Lehigh Dam.

c. Operating Records. There are no formal records of operation.

d. Post-construction Changes. There is very little information concerning modifications to the dam. The placement of an earthfill layer over the rockfill embankment may have resulted in some of the depressions observed on the crest of the dam.

e. Seismic Stability. Because there are concerns for the dam and appurtenant structures under normal operating conditions, it cannot be assumed that they would be stable under seismic loading conditions.

SECTION 7

ASSESSMENT, RECOMMENDATIONS, AND PROPOSED REMEDIAL MEASURES

7.1 Dam Assessment.

a. Safety.

(1) Based on visual inspection, available records, and engineering calculations, Lake Lehigh Dam is considered to be in poor condition. Subsequent to the inspection, the Owner has taken the following measures in order to reduce the hazards associated with the dam:

(a) Engaged an engineer to develop plans for rehabilitation of the structure.

(b) Developed an emergency operation and warning plan.

(c) Breached a portion of the dam which has lowered the pool level approximately three feet.

Based on conditions at the time of the inspection, the dam was judged to be unsafe, emergency. Because of the recent actions taken by the Owner, the dam was reassessed as unsafe, nonemergency. Based on conditions at the time of the inspection, the spillway will pass only two percent of the PMF without overtopping the dam. It is judged that the dam would fail during a storm event substantially less than its SDF. Failure of the dam would cause an increased hazard for loss of life. Based on criteria established for these studies, the spillway capacity is rated as seriously inadequate.

(2) The spillway timbers are badly deteriorated. Seepage is extensive and is estimated at 500 gpm. The seepage is concentrated at the ends of the principal spillway and has probably contributed to settlement of the embankment. As previously mentioned, the embankment shows several signs of distress.

(3) There are no means of drawing down the reservoir since the outlet works facilities are nonfunctional.

(4) A summary of the features and observed deficiencies is listed below:

Feature	Observed Deficiency
Embankment	Low areas adjacent to principal spillway; sloughed area to left of principal spillway; several low areas on crest; sparse riprap; seepage; trees and brush.
Principal Spillway	Deteriorated timbers; seepage.
Emergency Spillway	Nonfunctional.
Outlet Works	Nonfunctional.

b. Adequacy of Information. The information available is such that an assessment of the dam can be inferred from the combination of visual inspection, available information, and calculations performed prior to and as part of this study.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented immediately.

d. Necessity for Further Investigations. Accomplishment of the measures outlined in Paragraph 7.2 will require further investigations by the Owner.

7.2 Recommendations and Remedial Measures.

a. The following measures listed in approximate order of priority, are recommended to be immediately undertaken by the Owner:

(1) Continue to maintain the reservoir at its present (lowered) pool level. The breach in the dam should be of sufficient size that it is not possible to impound any significant quantity of water behind the dam during a flood.

(2) Continue developing plans to repair or remove the dam and its appurtenant structures. If the Owner chooses to repair the dam, he should perform additional studies to more accurately ascertain the spillway capacity required for Lake Lehigh Dam as well as

the nature and extent of mitigation measures required to make the spillway hydraulically adequate. Appropriate action should be taken as required. In addition, repairs to the dam should address the various deficiencies noted in this report. All investigations, studies, designs, and inspection of construction should be performed by a professional engineer experienced in the design and construction of dams.

b. In addition, the Owner should institute the following operational procedures:

(1) During periods of unusually heavy rains, provide round-the-clock surveillance of the dam.

(2) When warnings of a major storm are given by the National Weather Service, the Owner should activate his emergency operation and warning plan.

c. If the Owner chooses to repair the dam he should institute the following maintenance procedures:

(1) Institute an inspection program such that the dam is inspected on a regular basis. As presently required by the Commonwealth, the inspection program should include a formal annual inspection by a professional engineer experienced in the design and construction of dams. Utilitze the inspection results to determine if remedial measures are necessary.

(2) Institute a maintenance program and develop a formal maintenance manual so that all features of the dam are properly maintained.

APPENDIX A

CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: LAKE LEHIGH DAM

NDI ID NO.: PA-00151 DER ID NO.: 64-51

Sheet 1 of 4

ITEM	REMARKS
AS-BUILT DRAWINGS	None available
REGIONAL VICINITY MAP	See Plate E-1 (Appendix E)
CONSTRUCTION HISTORY	Very little information available; brief history contained in July 1915 permit application. (Penn DER file)
TYPICAL SECTIONS OF DAM	See Plate E-2 (Appendix E)
OUTLETS: Plan Details Constraints Discharge Ratings	None

ENGINEERING DATA

ITEM	REMARKS
RAINFALL/RESERVOIR RECORDS	None
DESIGN REPORTS	Permit application report prepared by Commonwealth July 1915 presents pertinent information on the structure.
GEOLOGY REPORTS	See Appendix F
DESIGN COMPUTATIONS: Hydrology and Hydraulics Dam Stability Seepage Studies	None
MATERIALS INVESTIGATIONS: Boring Records Laboratory Field	None
POSTCONSTRUCTION SURVEYS OF DAM	None

ENGINEERING DATA

ITEM	REMARKS
BORROW SOURCES	Unknown
MONITORING SYSTEMS	None
MODIFICATIONS	Emergency spillway was constructed some time after 1915; no other information is available.
HIGH POOL RECORDS	None
POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS	None
PRIOR ACCIDENTS OR FAILURE OF DAM: Description Reports	No information available

ENGINEERING DATA

ITEM	REMARKS
MAINTENANCE AND OPERATION RECORDS	None
SPILLWAY: Plan Sections Details	See Exhibit B-1 (Appendix B) and Plate E-2 (Appendix E)
OPERATING EQUIPMENT: Plans Details	Not applicable
PREVIOUS INSPECTIONS Dates Deficiencies	July 1915 - spillway capacity inadequate; slight leakage under spillway section. Oct. 1934 - Brush growing on embankment June 1938 - Good condition; spillway dimensions 80 feet x 11 inches March 1965 - OK - slight erosion at left side of drawdown sluiceway

APPENDIX B

CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: Lake Lehigh Dam County: Wayne and Lackawanna State: Pennsylvania

NDI ID No.: PA-00151 DER ID No.: 64-51

Type of Dam: Earth/rock fill & stone masonry Hazard Category: High

Date(s) Inspection: 29 October 1980, 6 November 1980 Weather: Overcast, Windy Temperature: 40°F

Pool Elevation at Time of Inspection: 1871.6 ft. msl/Tailwater at Time of Inspection: 1866.7 ft. msl

Note: Elevations referenced to pool level (1873 feet) noted on USGS quadrangle

Inspection Personnel:	Follow-up inspection:	
W.B. Bingham (GFCC)	J. Evans (COE)	E. Hecker (COE)
R.E. Holderbaum (GFCC)	J. Bianco (COE)	J. Boswell (DER)
D.R. Ebersole (GFCC)	B. Cortright (COE)	E. Gingrich (DER)
		W. Bingham (GFCC)
		F. Futchko (GFCC)

R.E. Holderbaum Recorder

B-1

EMBANKMENT

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	None	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	None	
SLOUGHING OR EROSION: Embankment Slopes Abutment Slopes	Low or eroded areas on both sides of principal spillway; sloughed area on downstream edge of dam crest to left of spillway.	See Exibit B-1 Low areas may be caused by internal erosion or previous overtopping.
CREST ALIGNMENT: Vertical Horizontal	Vertical- several low areas as shown on Exhibit B-1 and Plate E-2	
RIPRAP FAILURES	Riprap on upstream slope is sparse in a few areas.	

EMBANKMENT

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT WITH: Abutment Spillway Other Features	Low areas (12-18") at both spillway abutments	See previous page (SLOUGHING OR EROSION)
ANY NOTICEABLE SEEPAGE	Total seepage approximately 500 gpm.; concentrated seepage at both spillway abutments.	Substantial portion of seepage is probably flowing under or through spillway section.
STAFF GAGE AND RECORDER	None	
DRAINS	None	
TREES AND BRUSH	The crest, upstream slope and toe of the dam are partially covered with brush and small trees.	Trees range in size up to six inches in diameter.

CONCRETE/MASONRY DAMS

Sheet 1 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	See previous page (ANY NOTICEABLE SEEPAGE)	
JUNCTION OF STRUCTURE WITH: Abutment Embankment Other Features	Depression along top of masonry wall to right of principal spillway. (20' long, 3' wide, 18" deep)	See Exhibit B-1 for location.
DRAINS	None	
WATER PASSAGES	N/A	
FOUNDATION	Unknown	

CONCRETE/MASONRY DAMS

Sheet 2 of 2

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SURFACES: Surface Cracks Spalling	N/A	
STRUCTURAL CRACKING	N/A	
ALIGNMENT: Vertical Horizontal	Top of wall is lower than embankment at left end of dam.	
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	N/A	
STAFF GAGE OR RECORDER	None	

OUTLET WORKS

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Wooden sluiceway with low level outlet pipe is no longer functional	Both have been backfilled with soil and/or rock.
INTAKE STRUCTURE	N/A	
OUTLET STRUCTURE	N/A	
OUTLET CHANNEL	Originally discharged into stream channel below dam.	
EMERGENCY GATE	None	

UNGATED SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Rock-filled timber crib; timbers are very badly deteriorated; spillway crest is surfaced with stone and small rock.	Spillway could probably not withstand substantial ice loading or large discharges from reservoir.
APPROACH CHANNEL	Lake; unobstructed.	
DISCHARGE CHANNEL	Lehigh River	
BRIDGE AND PIERS	None	
SEEPAGE	Extensive seepage at both ends of, and through (or under) spillway. Total seepage ~ 500 gpm.	

EMERGENCY SPILLWAY

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	Spillway is a vegetated side channel located at right abutment of dam.	Spillway crest is higher than minimum top of dam; therefore nonfunctional.
APPROACH CHANNEL	Brush and small trees in channel.	
DISCHARGE CHANNEL	Brush and small trees in channel	Discharges into Lehigh River downstream from dam.
BRIDGE AND PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

INSTRUMENTATION

Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER		

RESERVOIR AND WATERSHED

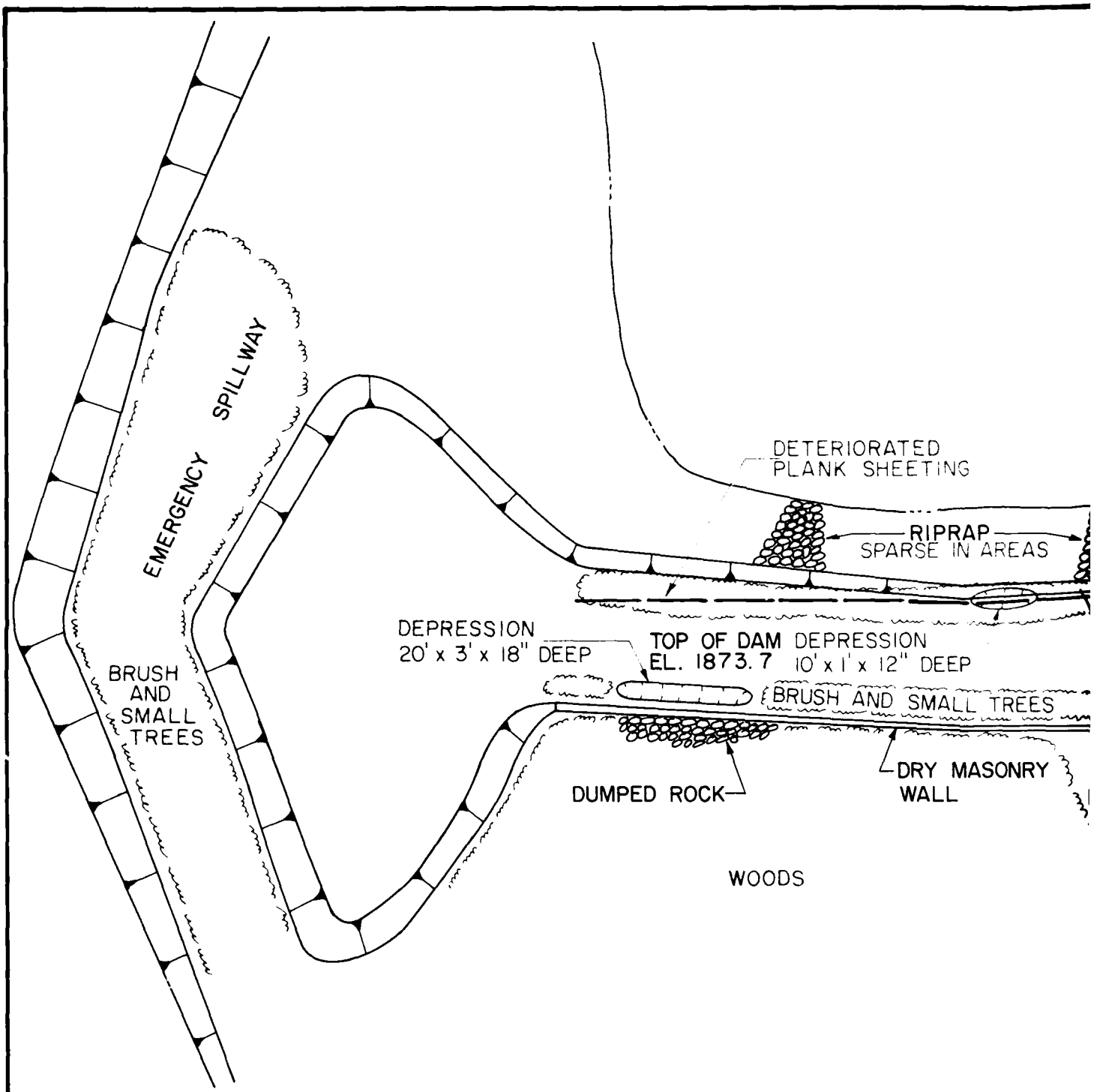
Sheet 1 of 1

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Reservoir slopes are mild to moderate and mostly wooded.	
SEDIMENTATION	Unknown	Probably trapped by upstream reservoirs.
WATERSHED DESCRIPTION	six dams and several small ponds are located in the watershed; watershed is mostly wooded.	Refer to Appendix D for a description and evaluation of these dams.

DOWNSTREAM CHANNEL

Sheet 1 of 1

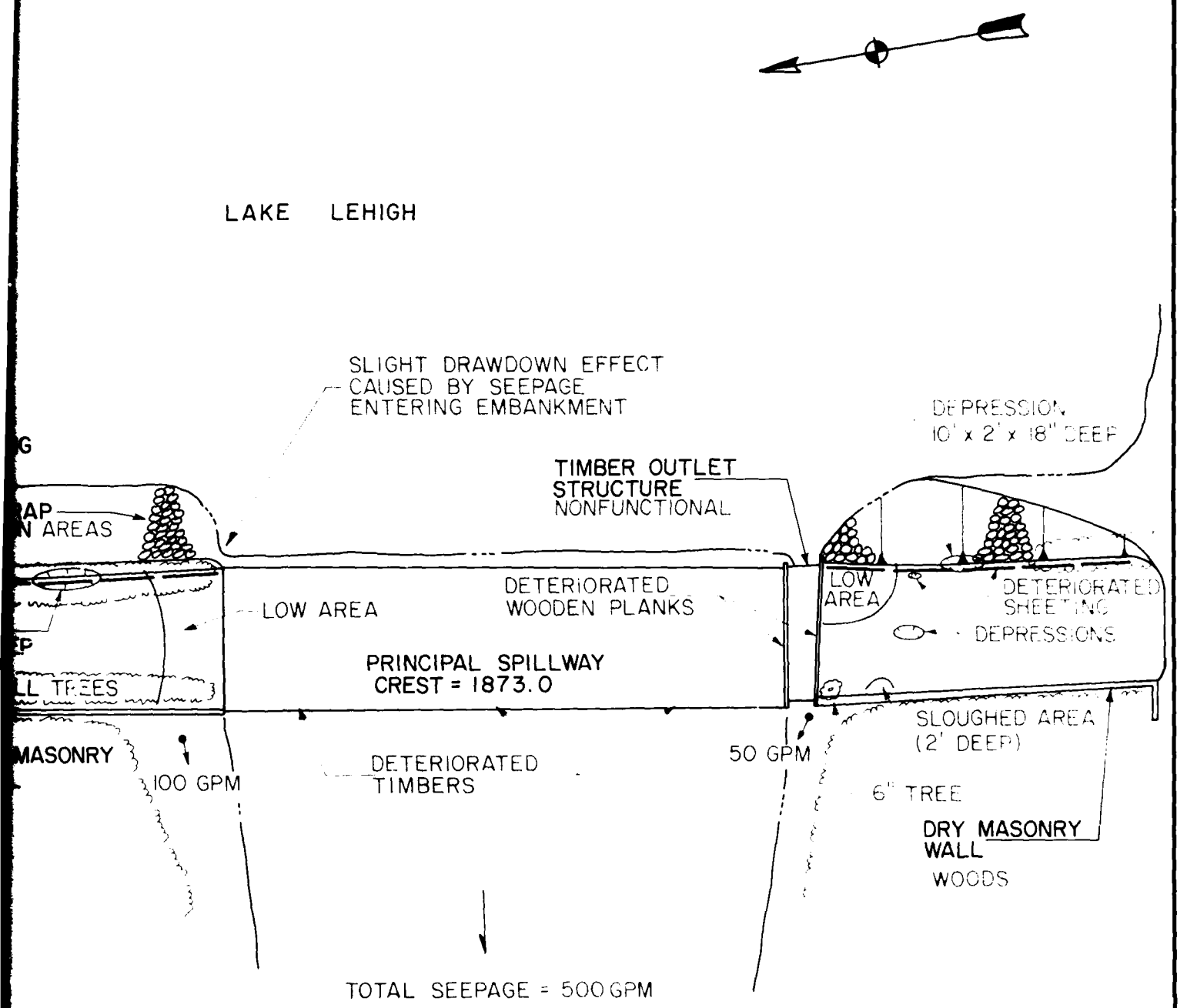
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION: Obstructions Debris Other	No obstructions immediately downstream from dam.	
SLOPES	Streambed slope is less than one percent; overbanks are moderately sloping and wooded.	
APPROXIMATE NUMBER OF HOMES AND POPULATION	Several homes are located approximately one mile downstream.	Possible loss of life and appreciable property damage could be expected in the event of a dam failure.



DATE OF INSPECTION: 29 OCTOBER 1980
POOL ELEVATION: 1871.6 FEET

SCALE: 1 IN = 20 FT. ±

20 0 20



= 20 FT. ±

20 40

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE LEHIGH DAM

D. M. BRANDON, D. C. BRANDON
AND D. L. BRANDON

RESULTS OF VISUAL INSPECTION

JANUARY 1981 EXHIBIT B-1

APPENDIX C

PHOTOGRAPHS

LAKE LEHIGH DAM

A. (Above) Downstream face of right end of dam.

B. (Left) Downstream side of principal spillway.

C. Crest of principal spillway looking toward left abutment.

D. Low area at left spillway abutment.

E. Downstream face of principal spillway.

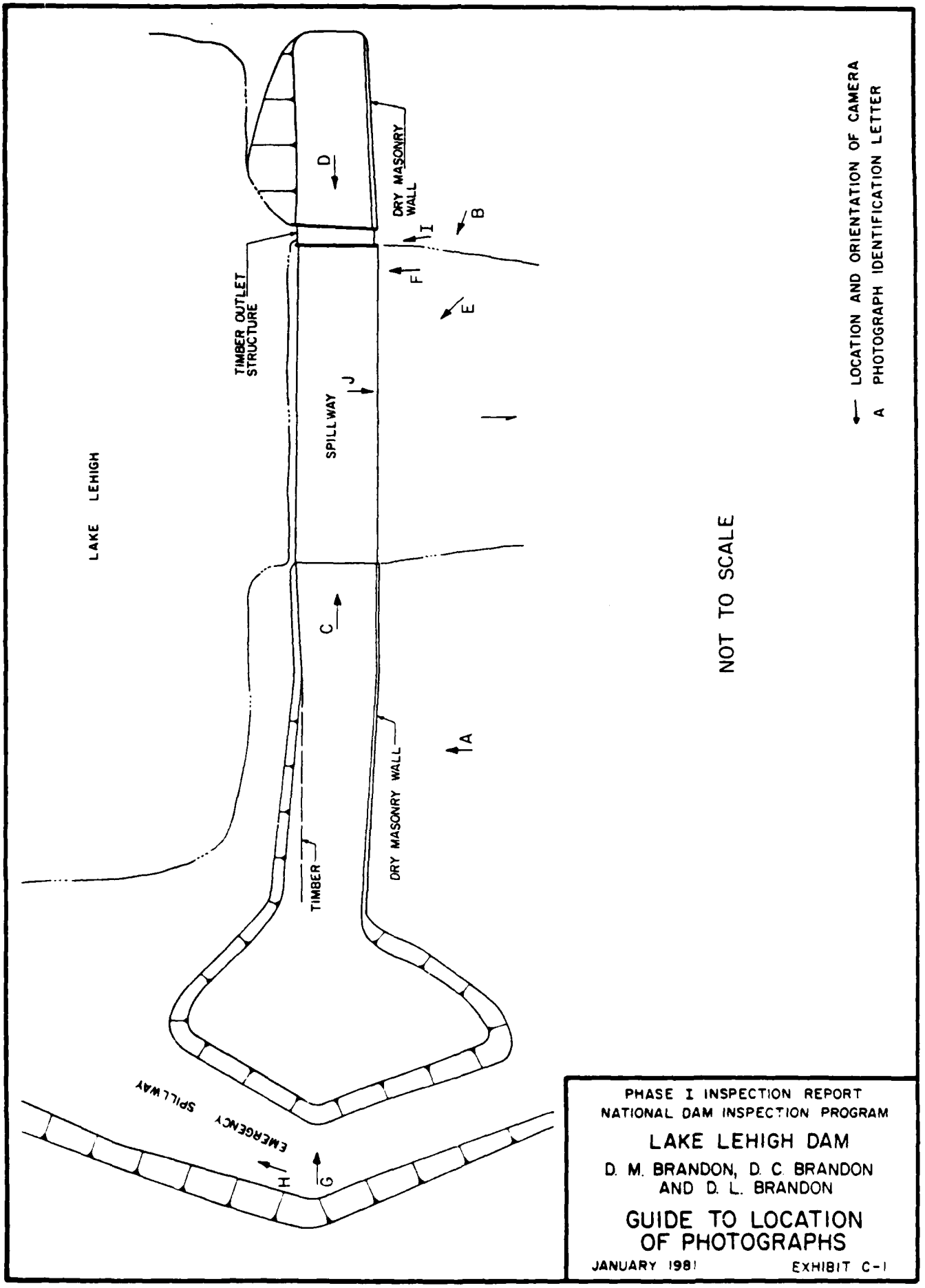
F. Downstream face of principal spillway (right end).

G. Crest of dam looking toward left abutment

H. Emergency spillway approach channel.

I. Close-up of timbers adjacent to outlet works.

J. Lehigh River just downstream from dam.



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE LEHIGH DAM

D. M. BRANDON, D. C. BRANDON
AND D. L. BRANDON

GUIDE TO LOCATION OF PHOTOGRAPHS

JANUARY 1981 EXHIBIT C-1

APPENDIX D

HYDROLOGY AND HYDRAULICS

APPENDIX D

HYDROLOGY AND HYDRAULICS

Spillway Capacity Rating:

In the recommended Guidelines for Safety Inspection of Dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended Spillway Design Flood (SDF) for the size (small, intermediate, or large) and hazard potential (low, significant, or high) classification of a dam is selected in accordance with the criteria. The SDF for those dams in the high hazard category varies between one-half of the Probable Maximum Flood (PMF) and the PMF. If the dam and spillway are not capable of passing the SDF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, or if the dam is not in the high hazard category, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

Description of Model:

If the Owner has not developed a PMF for the dam, the watershed is modeled with the HEC-1DB computer program, which was developed by the U.S. Army Corps of Engineers. The HEC-1DB computer program calculates a PMF runoff hydrograph (and percentages thereof) and routes the flows through both reservoirs and stream sections. In addition, it has the capability to simulate an overtopping dam failure. By modifying the rainfall criteria, it is also possible to model the 100-year flood with the program.

APPENDIX D

DELAWARE River Basin
Name of Stream: LEHIGH RIVER
Name of Dam: LAKE LEHIGH DAM
NDI ID No.: PA-00151
DER ID No.: 64-51
Latitude: N 41° 14.9' Longitude: W 75° 28.0'
Top of Dam Elevation: 873.7
Streambed Elevation: 1364.0 ± Height of Dam: 10 ft
Reservoir Storage at Top of Dam Elevation: 163 acre-ft
Size Category: SMALL
Hazard Category: HIGH (see Section 5)
Spillway Design Flood: ½ PMF TO PMF - USE ½ PMF (SEE SECTION 5)

UPSTREAM DAMS

Name	Distance from Dam (miles)	Height (ft)	Storage at top of Dam Elevation (acre-ft)	Remarks
CRYSTAL LAKE	4.5	13	755	DER ID. 64-6
UPPER KLONDIKE	1.6	14	181	DER ID. 64-175
LOWER KLONDIKE	1.3	18	219	DER ID 64-175
JOHNSON POND	0.7	11±	328	DER ID. 35-30

DOWNSTREAM DAMS - NONE

LAKE WATAWGA*	2.2	12	654	DER ID 64-38
GOULDSBORO*	2.4	18±	1500	DER. ID. 64-148

* UPSTREAM DAMS (CONTINUED)

DELAWARE River Basin

Name of Stream: LEHIGH RIVER

Name of Dam: LAKE LEHIGH DAM

DETERMINATION OF PMF RAINFALL & UNIT HYDROGRAPH

UNIT HYDROGRAPH DATA:

Sub-area	Drainage Area (square miles)	Cp (1)	Ct (2)	L miles (3)	L_{ca} miles (4)	L' miles (5)	Tp hours (6)	Map Area (7)	Plate (8)
A-1	2.57	0.45	2.1	2.08	0.61	—	2.26	2	B
A-2	3.88	0.45	2.1	—	—	2.40	3.55	2	B
A-3	0.42	0.45	2.1	1.89	0.70	—	2.28	2	B
A-4	0.77	0.45	2.1	—	—	0.59	1.53	2	B
A-5	4.69	0.45	2.1	3.41	2.03	—	3.75	2	B
Total	NEXT PAGE								

(See Sketch on Sheet D-4)

(1) & (2): Snyder Unit Hydrograph coefficients supplied by Baltimore District, Corps of Engineers on maps and plates referenced in (7) & (8)

The following are measured from the outlet of the subarea:

(3): Length of main watercourse extended to divide

(4): Length of main watercourse to the centroid

The following is measured from the upstream end of the reservoir at normal pool:

(5): Length of main watercourse extended to divide

(6): $Tp=C_t \times (L \times L_{ca})^{0.3}$, except where the centroid of the subarea is located in the reservoir. Then $Tp=C_t \times (L')^{0.6}$

Initial flow is assumed at 1.5 cfs/sq. mile

Computer Data: QRCSN = -0.05 (5% of peak flow)
RTIOR = 2.0

RAINFALL DATA:

PMF Rainfall Index= 21.9 in., 200 sq. mile

	Hydromet. 40 (Susquehanna Basin)	Hydromet. 33 (Other Basins)
Zone:	N/A	1
Geographic Adjustment Factor:		1.0
Revised Index Rainfall:		21.9

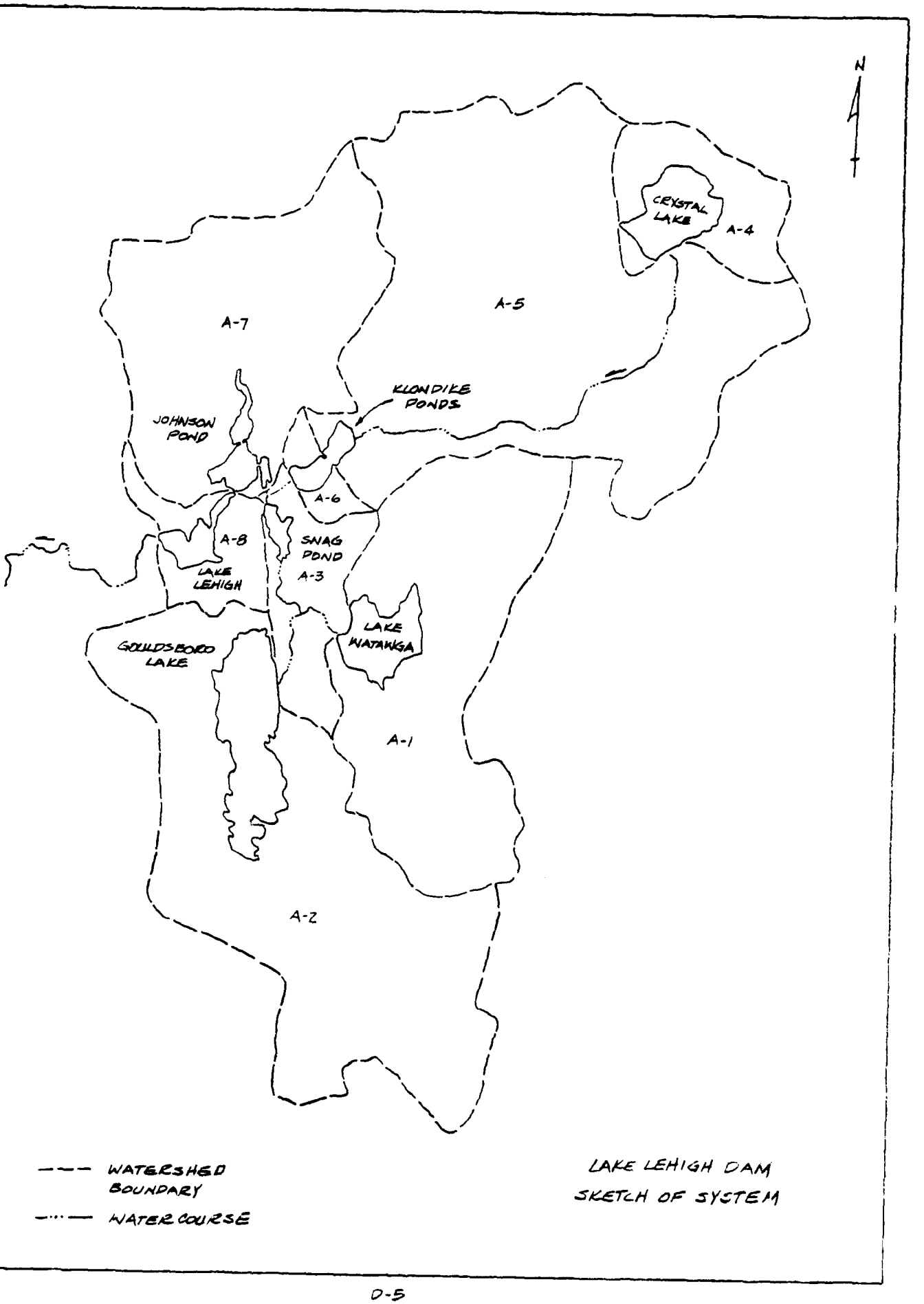
RAINFALL DISTRIBUTION (percent)

Time	Percent
6 hours	111
12 hours	123
24 hours	133
48 hours	142
72 hours	
96 hours	

BY DEH DATE 12/31/80 SUBJECT LAKE LEHIGH DAM SHEET NO ____ OF ____
CHKD BY ____ DATE ____ UNIT HYDROGRAPH DATA JOB NO ____

Sub-area	Drainage Area	Cp (1)	Ct (2)	L (3)	Lca (4)	L' (5)	Tp (6)	Map Area (7)	Plate (8)
A-6	0.17	0.45	2.1	—	—	0.40	1.21	2	B
A-7	2.89	0.45	2.1	2.69	1.01	—	2.83	2	B
A-8	0.31	0.45	2.1	—	—	0.50*	1.39	2	B
TOTAL	15.70								

* Estimated average length



LAKE LEHIGH DAM
SKETCH OF SYSTEM

Data for Dam at Outlet of Subarea A-1

Name of Dam: LAKE WATAUGA DAM

SPILLWAY DATA: TAKEN FROM PHASE I REPORT FOR LAKE WATAUGA DAM (1980)

	Existing Conditions	Design Conditions (N/A)
Top of Dam Elevation	1921.6	
Spillway Crest Elevation	1920.0	
Spillway Head Available (ft)	1.6	
Type Spillway	CONCRETE WEIR- FREE OVERFALL	
"C" Value - Spillway	3.1	
Crest Length - Spillway (ft)	51.0	
Spillway Peak Discharge (cfs)	320	
Auxiliary Spillway Crest Elev.	N/A	
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)		
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve: $Q = CLH^{1.5} = 3.1(51)H^{1.5}$

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet	NO OUTLET WORKS		
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance			
K Exit			
K Friction=$29.1_N{}^2L/R^{4/3}$			
Sum of K			
$(1/K)^{0.5} = C$			
Maximum Head (ft) = HM			
$Q = CA\sqrt{2g(HM)}$ (cfs)			
Q Combined (cfs)			

Data for Dam at Outlet of Subarea A-1 (See sketch on Sheet D-4)

Name of Dam: LAKE WATAUGA DAM

STORAGE DATA: TAKEN FROM PHASE I REPORT FOR LAKE WATAUGA DAM

Elevation		Area (acres)		Storage million gals	acre-ft		Remarks
1909.4	=ELEVO*	0		0	0		STREAMBED
1920.0	=ELEV1	125	=A1	144	442	=S1	NORMAL POOL
1921.6		140		213	654		TOP OF DAM
1940.0		376					

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 8 percent of subarea watershed.

BREACH DATA: NO BREACH ANALYSIS REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & $A = L \cdot depth$

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL= _____ mins = _____ hrs (time for breach to develop)

Data for Dam at Outlet of Subarea A-2

Name of Dam: GOULDSBORO DAM

SPILLWAY DATA: TAKEN FROM PHASE I REPORT FOR GOULDSBORO DAM - JULY 1979

	Existing Conditions	Design Conditions (N/A)
Top of Dam Elevation	1901.7	
Spillway Crest Elevation	1894.0	
Spillway Head Available (ft)	7.7	
Type Spillway	CONCRETE DROP INLET	
"C" Value - Spillway	2.85	
Crest Length - Spillway (ft)	13.25 (INSIDE LENGTH OF WEIR)	
Spillway Peak Discharge (cfs)	149 *	
Auxiliary Spillway Crest Elev.	1895.5	
Auxiliary Spill. Head Avail. (ft)	6.2	
Type Auxiliary Spillway	OPEN CHANNEL	
"C" Value - Auxiliary Spill. (ft)	N/A	
Crest Length - Auxil. Spill. (ft)	130 (BOTTOM WIDTH)	
Auxiliary Spillway Peak Discharge (cfs)	2970	
Combined Spillway Discharge (cfs)	3119	

* ASSUMED CONSTANT FOR HEADS ABOVE 2.5 FEET

Spillway Rating Curve: (SEE BELOW)

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)
1894.0			0
1895.0			38
1895.5			69
1896.5			290
1897.5			596
1898.5			1029
1899.5			1570

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet			
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N	N/A		
K Entrance	N/A		
K Exit			
K Friction=$29.1N^2L/R^{4/3}$			
Sum of K			
$(1/K)^{0.5}$ = C			
Maximum Head (ft) = HM			
$Q = CA\sqrt{2g(HM)}$ (cfs)			
Q Combined (cfs)			

Data for Dam at Outlet of Subarea A-2 (See sketch on Sheet D-4)

Name of Dam: GOULDSBORO DAM

STORAGE DATA: TAKEN FROM PHASE I REPORT FOR GOULDSBORO DAM

Elevation		Area (acres)		Storage million gals	acre-ft		Remarks
	=ELEVO*	0		0	0		
1894.0	=ELEV1	260	=A1	355	1089	=S1	NORMAL POOL
1900.0				1825	5601		
1910.0				3046	9348		

* ELEVO = ELEV1 - $(3S_1/A_1)$
** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 10 percent of subarea watershed.

BREACH DATA: NO BREACH ANALYSIS REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL= _____ mins = _____ hrs (time for breach to develop)

Data for Dam at Outlet of Subarea A-4

Name of Dam: CRYSTAL LAKE DAM

SPILLWAY DATA: (TAKEN FROM PHASE I REPORT FOR CRYSTAL LAKE DAM (1981))	Existing Conditions	Design Conditions
		(N/A)
Top of Dam Elevation	2058.4	
Spillway Crest Elevation	2055.9	
Spillway Head Available (ft)	2.5	
Type Spillway	BROAD-CRESTED CONCRETE	
"C" Value - Spillway	2.7	
Crest Length - Spillway (ft)	29.5	
Spillway Peak Discharge (cfs)	315	
Auxiliary Spillway Crest Elev.		
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)	N/A	
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve: $Q = CLH^{1.5} = 2.7(29.5)H^{1.5} = 79.7H^{1.5}$

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)

OUTLET WORKS RATING:	Outlet 1*	Outlet 2	Outlet 3
Invert of Outlet	2046.0		
Invert of Inlet	2046.7		
Type	STEEL		
Diameter (ft) = D	2.8 FT.		
Length (ft) = L	30 FT.		
Area (sq. ft) = A	6.15		
N	0.015		
K Entrance	0.5		
K Exit	1.0		
K Friction=$29.1N^2L/R^{4/3}$	0.3		
Sum of K	1.8		
$(1/K)^{0.5} = C$	0.75		
Maximum Head (ft) = HM	10.0±		
$Q = CA\sqrt{2g(HM)}$ (cfs)	117		
Q Combined (cfs)	N/A		

* NOT INCLUDED IN FLOOD ROUTING ANALYSIS

Data for Dam at Outlet of Subarea A-4 (See sketch on Sheet D-4)

Name of Dam: CRYSTAL LAKE DAM

STORAGE DATA: TAKEN FROM PHASE I REPORT FOR CRYSTAL LAKE DAM

Elevation		Area (acres)		Storage million gals	acre-ft		Remarks
2046.9	=ELEVO*	0		0	0		
2055.9	=ELEV1	133	=A1	130	399	=S1	SPILLWAY CREST
2058.4		152		246	754		LOW TOP OF DAM
2060.0		164		328	1007		
2080.0 **		259		1694	5200		

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 27 percent of subarea watershed.

BREACH DATA: NO BREACH ANALYSIS REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL= _____ mins = _____ hrs (time for breach to develop)

Data for Dam at Outlet of Subarea A-5

Name of Dam: UPPER KLONDIKE DAM

SPILLWAY DATA: TAKEN FROM PHASE I REPORT FOR LOWER KLONDIKE DAM (1980)

	Existing Conditions	Design Conditions (N/A)
Top of Dam Elevation	1906.6 (MINIMUM)	
Spillway Crest Elevation	1902.0	
Spillway Head Available (ft)	4.6	
Type Spillway	BROAD-CRESTED CONCRETE	
"C" Value - Spillway	2.7	
Crest Length - Spillway (ft)	140.0	
Spillway Peak Discharge (cfs)	3729	
Auxiliary Spillway Crest Elev.	N/A	
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)		
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve: $Q = CLH^{1.5} = (2.7)(140)(H^{1.5})$

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet			
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance	N/A		
K Exit			
K Friction $=29.1 N^2 L/R^{4/3}$			
Sum of K			
$(1/K)^{0.5} = C$			
Maximum Head (ft) = HM			
$Q = CA\sqrt{2g(HM)}$ (cfs)			
Q Combined (cfs)			

Data for Dam at Outlet of Subarea A-5 (See sketch on Sheet D-4)

Name of Dam: UPPER KLONDIKE DAM

STORAGE DATA: TAKEN FROM PHASE I REPORT FOR LOWER KLONDIKE DAM

Elevation		Area (acres)		Storage million gals	acre-ft		Remarks
1892.6	=ELEVO*	0		0	0		STM BED AT TOE
1902.0	=ELEV1	20	=A1	20	63	=S1	FROM DESIGN DRAWINGS
1906.6		32		59	181		TOP OF DAM
1920.0 **		81		297	910		

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 1 percent of subarea watershed.

BREACH DATA: BREACH ANALYSIS NOT REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL= _____ mins = _____ hrs (time for breach to develop)

Data for Dam at Outlet of Subarea A-6

Name of Dam: LOWER KLONDIKE DAM

SPILLWAY DATA: FROM PHASE I REPORT LOWER KLONDIKE DAM

	Existing Conditions	Design Conditions
Top of Dam Elevation	1899.6	1900.0
Spillway Crest Elevation	1895.1	1895.0
Spillway Head Available (ft)	4.5	5.0
Type Spillway	BROAD-CRESTED CONCRETE	
"C" Value - Spillway	2.7	2.7
Crest Length - Spillway (ft)	138	138
Spillway Peak Discharge (cfs)	3557	4165
Auxiliary Spillway Crest Elev.		
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)		
Crest Length - Auxil. Spill. (ft)	N/A	N/A
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve: $Q = CLH^{1.5} = (2.7)(138)H^{1.5}$

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)

OUTLET WORKS RATING:	Outlet 1*	Outlet 2	Outlet 3
Invert of Outlet	1884.0		
Invert of Inlet	1885.7		
Type	CMP		
Diameter (ft) = D	3		
Length (ft) = L	40		
Area (sq. ft) = A	7.07		
N	0.024		
K Entrance	0.5		
K Exit	1.0		
K Friction=$29.1N^2L/R^{4/3}$	1.0		
Sum of K	2.5		
$(1/K)^{0.5} = C$	0.6		
Maximum Head (ft) = HM	15.6		
$Q = CA\sqrt{2g(HM)}$ (cfs)	134		
Q Combined (cfs)	—		

* NOT INCLUDED IN ROUTING ANALYSIS

Data for Dam at Outlet of Subarea A-6 (See sketch on Sheet D-4)

Name of Dam: LOWER KLONDIKE DAM

STORAGE DATA: FROM PHASE I REPORT LOWER KLONDIKE DAM

Elevation		Area (acres)		Storage million gals	acre-ft		Remarks
1882.3	=ELEVO*	0		0	0		
1895.1	=ELEV1	22	=A1	31	94	=S1	A1 FROM DESIGN DRAWINGS
1899.6		34		71	218		TOP OF DAM
1900.0		35		76	233		DESIGN TOP OF DAM
1920.0**		150		635	1949		

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 20 percent of subarea watershed.

BREACH DATA: BREACH ANALYSIS NOT REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL= _____ mins = _____ hrs (time for breach to develop)

Data for Dam at Outlet of Subarea A-7

Name of Dam: JOHNSON POND DAM

SPILLWAY DATA:	Existing Conditions	Design Conditions
		(N/A)
Top of Dam Elevation	1881.1	
Spillway Crest Elevation	1878.0	
Spillway Head Available (ft)	3.1	
Type Spillway	CONCRETE OVERFLOW	
"C" Value - Spillway	3.1	
Crest Length - Spillway (ft)	70	
Spillway Peak Discharge (cfs)	1184	
Auxiliary Spillway Crest Elev.		
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)	N/A	
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve: $Q = CLH^{1.5} = 3.1(70)H^{1.5}$

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet			
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N	N/A		
K Entrance			
K Exit			
K Friction=$29.1n^2L/R^{4/3}$			
Sum of K			
$(1/K)^{0.5} = C$			
Maximum Head (ft) = HM			
$Q = CA\sqrt{2g(HM)}$ (cfs)			
Q Combined (cfs)			

Data for Dam at Outlet of Subarea A-7 (See sketch on Sheet D-4)

Name of Dam: JOHNSON POND DAM

STORAGE DATA:

Elevation		Area (acres)		Storage million gals	Storage acre-ft		Remarks
1874.0	=ELEVO*	0		0	0		
1878.0	=ELEV1	65	=A1	28	87	=S1	NORMAL POOL
1880.0		82					
1890.0	**	180					

* ELEVO = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 4 percent of subarea watershed.

BREACH DATA: BREACH ANALYSIS NOT REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL= _____ mins = _____ hrs (time for breach to develop)

Data for Dam at Outlet of Subarea A-8

Name of Dam: LAKE LEHIGH DAM

SPILLWAY DATA:	Existing Conditions	Design Conditions
Top of Dam Elevation	1873.7	(N/A)
Spillway Crest Elevation	1873.0	
Spillway Head Available (ft)	0.7	
Type Spillway	ROCK FILLED TIMBER CRIB	
"C" Value - Spillway	3.1	
Crest Length - Spillway (ft)	88	
Spillway Peak Discharge (cfs)	160	
Auxiliary Spillway Crest Elev.		
Auxiliary Spill. Head Avail. (ft)		
Type Auxiliary Spillway		
"C" Value - Auxiliary Spill. (ft)	N/A	
Crest Length - Auxil. Spill. (ft)		
Auxiliary Spillway Peak Discharge (cfs)		
Combined Spillway Discharge (cfs)		

Spillway Rating Curve: $Q = CLH^{1.5} = 3.1(88)H^{1.5}$

Elevation	Q Spillway (cfs)	Q Auxiliary Spillway (cfs)	Combined (cfs)

OUTLET WORKS RATING:	Outlet 1	Outlet 2	Outlet 3
Invert of Outlet			
Invert of Inlet			
Type			
Diameter (ft) = D			
Length (ft) = L			
Area (sq. ft) = A			
N			
K Entrance	N/A		
K Exit			
K Friction=$29.1N^2L/R^{4/3}$			
Sum of K			
$(1/K)^{0.5} = C$			
Maximum Head (ft) = HM			
$Q = CA\sqrt{2g(HM)}$ (cfs)			
Q Combined (cfs)			

Data for Dam at Outlet of Subarea A-8 (See sketch on Sheet D-4)

Name of Dam: LAKE LEHIGH DAM

STORAGE DATA:

Elevation		Area (acres)		Storage million gals	Storage acre-ft		Remarks
1864.0	=ELEVO*	0		0	0		
1873.0	=ELEV1	44	=A1	43	132	=S1	SPILLWAY CREST
1873.7		45±		53	163		TOP OF DAM
1880.0		48					

* ELEVO = ELEV1 - $(3S_1/A_1)$
** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 20 percent of subarea watershed.

BREACH DATA:

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: CLAY & SAND

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) 3.3 fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = 0.5 ft., C = 3.1 Top of Dam El.= 1873.7

HMAX + Top of Dam El. = 1874.2 = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = 100 ft (width of bottom of breach)
Z = 0.5 (side slopes of breach)
ELBM = 1864 FT. (bottom of breach elevation, minimum of zero storage elevation)
WSEL = 1873.0 (normal pool elevation)
T FAIL= 60 mins = 1.0 hrs (time for breach to develop)

BY _____ DATE _____ SUBJECT _____ SHEET NO _____ OF _____

CHKD BY _____ DATE _____ JOB NO _____

LAKE LEHIGH DAM

HYDROLOGIC AND HYDRAULIC ANALYSIS

General Procedure:

1. Hydrographs were developed for the Lake Watawga and Gouldsboro Lake watersheds.

2. These two hydrographs were then combined and routed downstream through Snag Pond. Although this does not represent the actual physical conditions it was done to simplify the routing computations. That is, outflow occurs at two locations from Gouldsboro Lake and one location from Lake Watawga (see quad). The information required to perform such an analysis would be rather detailed and would most likely result in only a small increase in accuracy. The resulting hydrograph was then combined with the runoff hydrograph for the Snag Pond area.

3. The hydrograph development and routing procedure then shifted to Crystal Lake and progressed down through Lower Klondike Pond. The resulting outflow hydrograph from Lower Klondike was then combined with resulting hydrograph at the Snag Pond area in step 2 above.

4. The routing then continued through Johnson Pond and Lake Lehigh.

5. During the breach analysis for Lake Lehigh Dam the outflows were routed downstream through two channel sections. The second cross-section is located at the damage center.

BY _____ DATE _____ SUBJECT _____ SHEET NO _____ OF _____

CHKD. BY _____ DATE _____ JOB NO _____

SELECTED COMPUTER OUTPUT

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                 A1                    NATIONAL DAM INSPECTION PROGRAM
    2                 A2                BALTIMORE DISTRICT CORPS OF ENGINEERS
    3                 A3                             LAKE LEHIGH DAM
    4                 B     300       0      15       0       0       0       0       0      -4       0
    5                 B1      5
    6                 J       1       4       1
    7                 J1    1.0     0.5     0.2    0.05
    8                 K       0       1                                       1
    9                 K1        INFLOW TO LAKE WATAWGA DAM
   10                 M       1       1    2.57              15.7                                   1
   11                 P               21.9     111     123     133     142
   12                 T                                                       1.0    0.05             0.08
   13                 W    2.26    0.45
   14                 X    -1.5   -0.05     2.0
   15                 K       1       1                                       1
   16                 K1        ROUTE THROUGH LAKE WATAWGA DAM
   17                 Y                                       1       0
   18                 Y1      1                                              -1920.0
   19                 $A      0     125     140     376
   20                 $E1909.4  1920.0  1921.6  1940.0
   21                 $$1920.0    51.0     3.1     1.5
   22                 $D1921.6
   23                 $L  89.5     124     212     295     379     450     730     730
   24                 $V1921.6  1921.7  1921.8  1922.0  1922.2  1922.5  1923.0  1925.0
   25                 K       0       2                                       1
   26                 K1        INFLOW TO GOULDSBORO DAM
   27                 M       1       1    3.88              15.7                                   1
   28                 P               21.9     111     123     133     142
   29                 T                                                       1.0    0.05             0.10
   30                 W    3.55    0.45
   31                 X    -1.5   -0.05     2.0
   32                 K       1       2                                       1
   33                 K1        ROUTE THROUGH GOULDSBORO DAM
   34                 Y                                       1       0
   35                 Y1      1                                              -1894      -1
   36                 Y41894.0  1895.0  1895.5  1896.5  1897.5  1898.5  1899.5
   37                 Y5      0      38      69     290     596    1029    1570
   38                 $S   1089    5601    9350
   39                 $E   1894    1900    1910
   40                 $$   1894
   41                 $D1901.7     2.5     1.5    1000
   42                 K       2       4                                       1
   43                 K1        COMPINE OUTFLOWS FROM LAKE WATAWGA AND GOULDSBORO DAM
   44                 K       1       3                                       1
   45                 K1        ROUTE DOWNSTREAM TO SNAG POND
   46                 Y                                       1       0
   47                 Y1      1                                              -1
   48                 Y6    0.1    0.07     0.1    1878    1900    3300   0.010
   49                 Y7      0    1900     150    1890     300    1880     300    1878     310    1878
   50                 Y7    310    1880     410    1890     510    1900
```

```
K       0       3                                                       1
K1       SUB-AREA RUNOFF BELOW WATAUGA GOULDSBORO          (SNAG POND)
M       1       1    0.42            15.7                                       1
P               21.9     111     123     133     142
T                                                       1.0     0.05            .07
W    2.28     0.45
X    -1.5    -0.05     2.0
K       2       3                                                       1
K1       COMBINE SUB-AREA SNAG POND WITH WATAUGA GOULDSBORO OUTFLOW
K       0       4                                                       1
K1       INFLOW TO CRYSTAL LAKE
M       1       1    0.77            15.7                                       1
P               21.9     111     123     133     142
T                                                       1.0     0.05            0.27
W    1.53     0.45
X    -1.5    -0.05     2.0
K       1       4                                                       1
K1       ROUTE THROUGH CRYSTAL LAKE
Y                               1       0
Y1      1                                                       -2055.9
SA      0     133     152     164     259
SE2046.9  2055.9  2058.4  2060.0  2080.0
SS2055.9    29.5     2.7     1.5
SD2058.4
SL      0      60     845     895     910
SV2058.4  2058.5  2059.0  2059.5  2060.0
K       1       5                                                       1
K1       ROUTE DOWNSTREAM TO KLONDIKE POND-STREAM SECTION 1
Y                               1       0
Y1      1                                                       -1
Y6    0.1     0.07     0.1  2017.0  2040.0    3300    0.004
Y7      0     2040     250    2020     495    2019      496     2017     504     2017
Y7    505     2019     850    2020    1000    2040
K       1       6                                                       1
K1       ROUTE DOWNSTREAM TO KLONDIKE POND-STREAM SECTION 2
Y                               1       0
Y1      1                                                       -1
Y6    0.1     0.07     0.1  2000.0  2030.0    4000    0.004
Y7      0     2030     250    2020    1195    2002     1196     2000    1204     2000
Y7   1205     2002    1820    2020    2000    2030
K       1       7                                                       1
K1       ROUTE DOWNSTREAM TO KLONDIKE POND-STREAM SECTION 3
Y                               1       0
Y1      1                                                       -1
Y6    0.1     0.07     0.1  1943.0  1980.0    7600    0.007
Y7      0     1980     300    1960     545    1945      546     1943     554     1943
Y7    555     1945     820    1960    1050    1980
K       0       8                                                       1
K1       INFLOW TO UPPER KLONDIKE POND
M       1       1    4.69            15.7                                       1
```

```
P            21.9      111      123      133      142
T                                                    1.0     0.05              0.01
W   3.75     0.45
X   -1.5    -0.05      2.0
K       2         8                                    1
K1       COMBINE FLOWS FROM CRYSTAL LAKE AND UPPER KLONDIKE SUB-AREA
K       1         8                                    1
K        ROUTE THROUGH UPPER KLONDIKE LAKE
Y                                  1         0
Y1      1                                          -1902.0
SA      0        20        32        81
SE1892.6  1902.0  1906.6  1920.0
SS1902.0      140       2.7       1.5
SO1906.6
SL      1      160       345       733       765       765
SV1906.6  1906.9  1907.0  1907.5  1908.0  1910.0
K       0         9                                    1
K1       SUB-AREA RUNOFF LOWER KLONDIKE DAM
M       1         1    0.17              15.7                                    1
P            21.9      111      123      133      142
T                                                    1.0     0.05              0.20
W   1.21     0.45
X   -1.5    -0.05      2.0
K       2         9                                    1
K1       COMBINE OUTFLOW FROM UPPER KLONDIKE WITH LOWER KLONDIKE SUB-AREA
K       1         9                                    1
K1       ROUTE THROUGH LOWER KLONDIKE LAKE
Y                                  1         0
Y1      1                                          -1895.1
SA      0        22        34        35       150
SE1882.3  1895.1  1899.6  1900.0  1920.0
SS1895.1      138       2.7       1.5
SO1899.6
SL      1      840      1180      1380
SV1899.6  1900.0  1900.5  1902.0
K       2        10                                    1
K1       COMBINE OUTFLOWS FROM KLONDIKE MATANUSKA & GOULDSBORO AT JOHNSON POND
K       0        10                                    1
K1       SUB-AREA RUNOFF JOHNSON POND
M       1         1    2.89              15.7                                    1
P            21.9      111      123      133      142
T                                                    1.0     0.05              0.04
W   2.83     0.45
X   -1.5    -0.05      2.0
K       2        10                                    1
K1       TOTAL INFLOW TO JOHNSON POND
K       1        10                                    1
K1       ROUTE THROUGH JOHNSON POND
Y                                  1         0
Y1      1                                          -1878
```

```
151              SA      0       65       82      180
152              SE   1874     1878     1880     1890
153              SS   1874       70      3.1      1.5
154              SD1881.1
155              SL     41       54      152      188      208      216
156              SV1881.1   1881.5   1882.0   1882.5   1883.0   1883.5
157              K       0       11                                    1
158              K1       SUB-AREA RUNOFF LAKE LEHIGH
159              M       1        1     0.31             15.7                              1
160              P               21.9      111      123      133      142
161              T                                                                                .20
162              W    1.39     0.45
163              X    -1.5    -0.05      2.0
164              K       2       11                                    1
165              K1       COMBINE OUTFLOW FROM JOHNSON POND & LAKE LEHIGH SUB-AREA RUNOFF
166              K       1       11                                    1
167              K1       ROUTE THROUGH LAKE LEHIGH
168              Y                                1        0
169              Y1      1                                          -1873
170              SA      0       44       48
171              SE1864.0     1873     1880
172              SS1873.0       88      3.1      1.5
173              SD1873.7
174              SL      0       26      115      186      248      278      278
175              SV1873.7   1874.0   1874.5   1875.0   1875.5   1876.0   1876.5
176              K      99
```

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1 1.00	RATIO 2 .50	RATIO 3 .20	RATIO 4 .05	
HYDROGRAPH AT	1	2.57	1	4836.	2417.	967.	242.	Lake Watawga Dam
	(	6.66)	(	136.87)(	68.44)(	27.37)(	6.84)(	
ROUTED TO	1	2.57	1	4690.	2224.	616.	93.	
	(	6.66)	(	132.82)(	62.98)(	17.44)(	2.64)(	
HYDROGRAPH AT	2	3.88	1	5477.	2738.	1095.	274.	Goulds boro Dam
	(	10.05)	(	155.08)(	77.54)(	31.02)(	7.75)(	
ROUTED TO	2	3.88	1	1130.	328.	48.	11.	
	(	10.05)	(	31.99)(	9.28)(	1.35)(	.31)(	
2 COMBINED	A	6.45	1	4849.	2265.	639.	101.	
	(	16.71)	(	137.31)(	64.15)(	18.10)(	2.86)(	
ROUTED TO	3	6.45	1	4835.	2258.	635.	101.	Snag Pond
	(	16.71)	(	136.92)(	63.94)(	17.99)(	2.85)(	
HYDROGRAPH AT	3	.42	1	789.	395.	158.	39.	
	(	1.09)	(	22.35)(	11.17)(	4.47)(	1.12)(	
2 COMBINED	3	6.87	1	5586.	2612.	731.	116.	
	(	17.79)	(	158.18)(	73.96)(	20.70)(	3.29)(	
HYDROGRAPH AT	4	.77	1	1811.	905.	362.	91.	Crystal Lake Dam
	(	1.99)	(	51.28)(	25.64)(	10.26)(	2.56)(	
ROUTED TO	4	.77	1	1293.	269.	82.	13.	
	(	1.99)	(	36.62)(	7.62)(	2.33)(	.35)(	
ROUTED TO	5	.77	1	1218.	265.	81.	12.	
	(	1.99)	(	34.48)(	7.51)(	2.30)(	.35)(	
ROUTED TO	6	.77	1	1127.	262.	80.	12.	
	(	1.99)	(	31.92)(	7.42)(	2.27)(	.35)(	
ROUTED TO	7	.77	1	1042.	258.	79.	12.	
	(	1.99)	(	29.51)(	7.32)(	2.23)(	.35)(	
HYDROGRAPH AT	8	4.69	1	6374.	3187.	1275.	319.	Upper Klondike Dam
	(	12.15)	(	180.50)(	90.25)(	36.10)(	9.02)(	
2 COMBINED	8	5.46	1	6963.	3298.	1304.	324.	
	(	14.14)	(	197.18)(	93.39)(	36.92)(	9.16)(	
ROUTED TO	8	5.46	1	6961.	3271.	1290.	317.	
	(	14.14)	(	197.11)(	92.62)(	36.54)(	8.98)(	

HYDROGRAPH AT	9	.17	1	451.	225.	90.	23.	Lower Klondike Dam
	(	.44)	(	12.76)(	6.38)(	2.55)(	.64)(	
2 COMBINED	9	5.63	1	7136.	3369.	1330.	326.	
	(	14.58)	(	202.07)(	95.41)(	37.66)(	9.23)(	
ROUTED TO	9	5.63	1	7137.	3341.	1315.	320.	
	(	14.58)	(	202.11)(	94.60)(	37.23)(	9.05)(	
2 COMBINED	10	12.50	1	12450.	5857.	2033.	432.	
	(	32.37)	(	352.53)(	165.84)(	57.56)(	12.24)(	
HYDROGRAPH AT	10	2.89	1	4753.	2377.	951.	238.	Johnson Pond Dam
	(	7.49)	(	134.60)(	67.30)(	26.92)(	6.73)(	
2 COMBINED	10	15.39	1	17018.	8091.	2841.	633.	
	(	39.86)	(	481.91)(	229.10)(	80.45)(	17.93)(	
ROUTED TO	10	15.39	1	16692.	7887.	2689.	530.	
	(	39.86)	(	472.66)(	223.33)(	76.15)(	15.00)(	
HYDROGRAPH AT	11	.31	1	768.	384.	154.	38.	Lake Lehigh Dam
	(	.80)	(	21.75)(	10.87)(	4.35)(	1.09)(	
2 COMBINED	11	15.70	1	17101.	8072.	2739.	538.	
	(	40.66)	(	484.25)(	228.56)(	77.56)(	15.22)(	
ROUTED TO	11	15.70	1	17081.	8049.	2727.	527.	
	(	40.66)	(	483.69)(	227.91)(	77.23)(	14.92)(	

SUMMARY OF DAM SAFETY ANALYSIS

Lake Lehigh Dam

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1873.00	1873.00	1873.70
STORAGE	132.	132.	163.
OUTFLOW	0.	0.	160.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	1880.39	6.69	472.	17081.	52.25	43.75	0.00
.50	1877.95	4.25	357.	8049.	41.75	44.25	0.00
.20	1875.99	2.29	266.	2727.	34.50	45.25	0.00
.05	1874.43	.73	195.	527.	18.50	47.25	0.00

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Overtopping Summary
Lake Lehigh Dam

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                 A1                    NATIONAL DAM INSPECTION PROGRAM
    2                 A2                BALTIMORE DISTRICT CORPS OF ENGINEERS
    3                 A3                          LAKE LEHIGH DAM
    4                 B     300        0       15        0        0        0        0        0       -4        0
    5                 B1      5
    6                 J       2        2        1
    7                 J1    .05     0.50
    8                 K       0        1                                                  1
    9                 K1        INFLOW TO LAKE WATAUGA DAM
   10                 M       1        1     2.57                15.7                                        1
   11                 P               21.9      111      123      133      142
   12                 T                                                            1.0     0.05                0.08
   13                 W    2.26     0.45
   14                 X    -1.5    -0.05      2.0
   15                 K       1        1                                                  1
   16                 K1        ROUTE THROUGH LAKE WATAUGA DAM
   17                 Y                                        1        1
   18                 Y1      1                                                  -1920.0
   19                 $A      0      125      140      376
   20                 $E1909.4  1920.0   1921.6   1940.0
   21                 $S1920.0    51.0      3.1      1.5
   22                 $D1921.6
   23                 $L   89.5      124      212      295      379      450      730      730
   24                 $V1921.6  1921.7   1921.8   1922.0   1922.2   1922.5   1923.0   1925.0
   25                 K       0        2                                                  1
   26                 K1        INFLOW TO GOULDSBORO DAM
   27                 M       1        1     3.88                15.7                                        1
   28                 P               21.9      111      123      133      142
   29                 T                                                            1.0     0.05                0.10
   30                 W    3.55     0.45
   31                 X    -1.5    -0.05      2.0
   32                 K       1        2                                                  1
   33                 K1        ROUTE THROUGH GOULDSBORO DAM
   34                 Y                                        1        1
   35                 Y1      1                                                   -1894       -1
   36                 Y41894.0  1895.0   1895.5   1896.5   1897.5   1898.5   1899.5
   37                 Y5      0       38       69      290      596     1029     1570
   38                 $S   1089     5601     9350
   39                 $E   1894     1900     1910
   40                 $$   1894
   41                 $D1901.7      2.5      1.5     1000
   42                 K       2        4                                                  1
   43                 K1        COMBINE OUTFLOWS FROM LAKE WATAUGA AND GOULDSBORO DAM
   44                 K       1        3                                                  1
   45                 K1        ROUTE DOWNSTREAM TO SNAG POND
   46                 Y                                        1        1
   47                 Y1      1                                                      -1
   48                 Y6    0.1     0.07      0.1     1878     1900     3300    0.010
   49                 Y7      0     1900      150     1890      300     1880      300     1878      310     1878
   50                 Y7    310     1880      410     1890      510     1900
```

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K       0       3                                                       1
K1       SUB-AREA RUNOFF BELOW WATAUGA GOULDSBORO                        (SNAG POND)
M       1       1    0.42              15.7                                        1
P              21.9      111      123      133      142
T                                                       1.0     0.05            .07
W    2.28     0.45
X    -1.5    -0.05      2.0
K       2       3                                                       1
K1       COMBINE SUB-AREA SNAG POND WITH WATAUGA GOULDSBORO OUTFLOW
K       0       4                                                       1
K1       INFLOW TO CRYSTAL LAKE
M       1       1    0.77              15.7                                        1
P                     111      123      133      142
T                                                       1.0     0.05            0.27
W    1.53     0.45
X    -1.5    -0.05      2.0
K       1       4                                                       1
K1       ROUTE THROUGH CRYSTAL LAKE
Y                                1       1
Y1      1                                                       -2055.9
SA      0     133      152      164      259
SE2046.9  2055.9  2058.4  2060.0  2080.0
SS2055.9    29.5      2.7      1.5
SD2058.4
SL      0      60      845      895      910
SV2058.4  2058.5  2059.0  2059.5  2060.0
K       1       5                                                       1
K1       ROUTE DOWNSTREAM TO KLONDIKE POND-STREAM SECTION 1
Y                                1       1
Y1      1                                                       -1
Y6    0.1    0.07      0.1  2017.0  2040.0     3300   0.004
Y7      0    2040      250    2020     495     2019     496     2017      504     2017
Y7    505    2019      850    2020    1000     2040
K       1       6                                                       1
K1       ROUTE DOWNSTREAM TO KLONDIKE POND-STREAM SECTION 2
Y                                1       1
Y1      1                                                       -1
Y6    0.1    0.07      0.1  2000.0  2030.0     4000   0.004
Y7      0    2030      250    2020    1195     2002     1196     2000     1204     2000
Y7   1205    2002     1820    2020    2000     2030
K       1       7                                                       1
K1       ROUTE DOWNSTREAM TO KLONDIKE POND-STREAM SECTION 3
Y                                1       1
Y1      1                                                       -1
Y6    0.1    0.07      0.1  1943.0  1980.0     7600   0.007
Y7      0    1980      300    1960     545     1945     546     1943      554     1943
Y7    555    1945      820    1960    1050     1980
K       0       8                                                       1
K1       INFLOW TO UPPER KLONDIKE POND
M       1       1    4.69              15.7                                        1
```

```
P            21.9     111     123     133     142
T                                                    1.0     0.05            0.01
W   3.75     0.45
X   -1.5    -0.05     2.0
K       2        8                                     1
K1      COMBINE FLOWS FROM CRYSTAL LAKE AND UPPER KLONDIKE SUB-AREA
K       1        8                                     1
K       ROUTE THROUGH UPPER KLONDIKE LAKE
Y                                1       1
Y1      1                                        -1902.0
$A      0       20       32       81
$E1892.6  1902.0  1906.6  1920.0
$$1902.0      140      2.7      1.5
$D1906.6
$L      1      160      345      733      765      765
$V1906.6  1906.9  1907.0  1907.5  1908.0  1910.0
K       0        9                                     1
K1      SUB-AREA RUNOFF LOWER KLONDIKE DAM
M       1        1     0.17            15.7                                    1
P            21.9     111     123     133     142
T                                                    1.0     0.05            0.20
W   1.21     0.45
X   -1.5    -0.05     2.0
K       2        9                                     1
K1      COMBINE OUTFLOW FROM UPPER KLONDIKE WITH LOWER KLONDIKE SUB-AREA
K       1        9                                     1
K1      ROUTE THROUGH LOWER KLONDIKE LAKE
Y                                1       1
Y1      1                                        -1895.1
$A      0       22       34       35      150
$E1882.3  1895.1  1899.6  1900.0  1920.0
$$1895.1      138      2.7      1.5
$D1899.6
$L      1      840     1180     1380
$V1899.6  1900.0  1900.5  1902.0
K       2       10                                     1
K1      COMBINE OUTFLOWS FROM KLONDIKE WATANGA & GOULDSBORO AT JOHNSON POND
K       0       10                                     1
K1      SUB-AREA RUNOFF JOHNSON POND
M       1        1    2.89            15.7                                    1
P            21.9     111     123     133     142
T                                                    1.0     0.05            0.04
W   2.83     0.45
X   -1.5    -0.05     2.0
K       2       10                                     1
K1      TOTAL INFLOW TO JOHNSON POND
K       1       10                                     1
K1      ROUTE THROUGH JOHNSON POND
Y                                1       1
Y1      1                                         -1878
```

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```
$A      0       65       82      180
$E   1874     1878     1880     1890
$S   1878       70      3.1      1.5
$D1881.1
$L     41       54      152      188      208      216
$V1881.1   1881.5   1882.0   1882.5   1883.0   1883.5
K       0       11                                    1
K1        SUB-AREA RUNOFF LAKE LEHIGH
M       1        1     0.31             15.7                                    1
P              21.9      111      123      133      142
T                                                                                .20
W    1.39     0.45
X    -1.5    -0.05      2.0
K       2       11                                    1
K1        COMBINE OUTFLOW FROM JOHNSON POND & LAKE LEHIGH SUB-AREA RUNOFF
K       1       11                                    1
K1        ROUTE THROUGH LAKE LEHIGH
Y                                       1        1
Y1      1                                            -1873
$A      0       44       48
$E1864.0     1873     1880
$S1873.0       88      3.1      1.5
$D1873.7
$L      0       26      115      186      248      278      278
$V1873.7   1874.0   1874.5   1875.0   1875.5   1876.0   1876.5
$B    100      0.5     1864      1.0     1873   1880.0
$B    100      0.5     1864      1.0     1873   1874.2
K       1       12                                    1
K1        STREAM SECTION NUMBER 1
Y                                       1        1
Y1      1                                           -1
Y6    0.1     0.05      0.1     1830     1850     4300   0.0079
Y7      0     1860      220     1840      255     1835      255     1830      285     1830
Y7    285     1835      350     1840     1200     1860
K       1       13                                    1
K1        STREAM SECTION NUMBER 2
Y                                       1        1
Y1      1                                           -1
Y6    0.1     0.05      0.1     1810     1830     3200   0.0063
Y7      0     1840      820     1820     1237     1817     1237     1810     1263     1810
Y7   1263     1817     1500     1820     2040     1840
K      99
```

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SUMMARY OF DAM SAFETY ANALYSIS

Lake Lehigh Dam

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1873.00	1873.00	1873.70
STORAGE	132.	132.	163.
OUTFLOW	0.	0.	160.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	1874.43	.73	195.	527.	18.50	47.25	0.00
.50	1877.95	4.25	357.	8049.	41.75	44.25	0.00

PLAN 2 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	1873.00	1873.00	1873.70
STORAGE	132.	132.	163.
OUTFLOW	0.	0.	160.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.05	1874.24	.54	187.	4760.	3.04	45.46	44.50
.50	1874.25	.55	187.	8011.	4.29	44.25	37.00

PLAN 1 STATION 12

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.05	527.	1833.4	47.25
.50	8019.	1843.7	44.25

PLAN 2 STATION 12

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.05	3863.	1840.3	45.50
.50	7985.	1843.7	44.50

PLAN 1 STATION 13

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.05	526.	1814.0	47.50
.50	7995.	1821.7	44.50

Dam Breach and Channel Routing Summary

Damage Center

PLAN 2 STATION 13

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.05	2875.	1819.5	45.75
.50	7962.	1821.7	44.75

Damage Center

BY _____ DATE _____ SUBJECT _____ SHEET NO _____ OF _____

CHKD BY _____ DATE _____ JOB NO _____

LAKE LEHIGH DAM

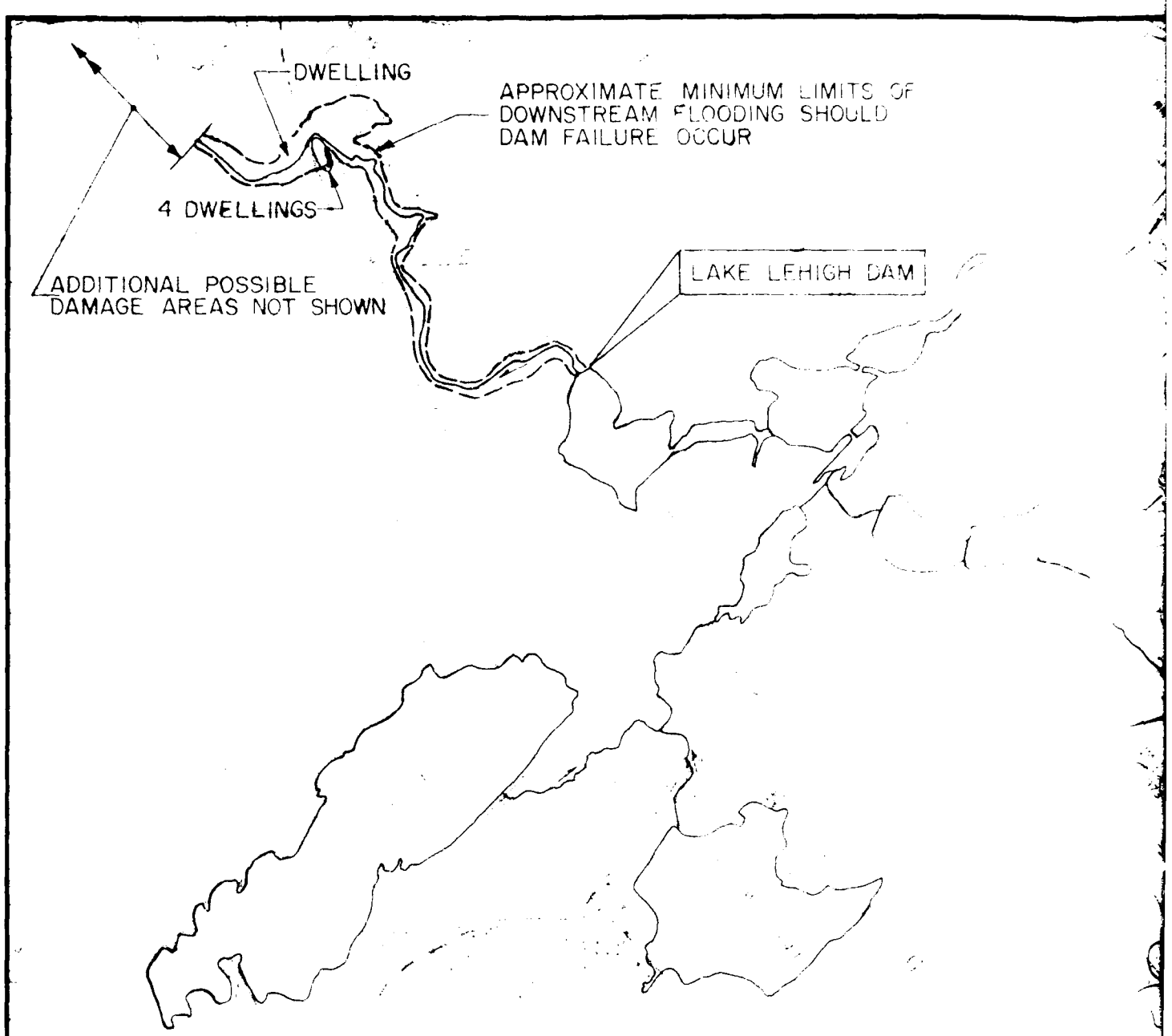
Summary of Pertinent Results

Multi-ratio Analysis:

	PMF	1/2 PMF
Rainfall (inches)	25.36	–
Runoff (inches)	~23.3	~11.65
Peak inflow (cfs)	17,101	8072
Peak outflow (cfs)	17,081	8049
Depth of overtopping (ft.)	6.69	4.25
Duration of overtopping (hrs.)	52.25	41.75

Breach and Routing Analysis: (5% PMF)

	No Failure	Failure	Difference
Peak Outflow (cfs)	526	2875	2349
Stream depth at Damage Center	1814.0	1819.5	5.5

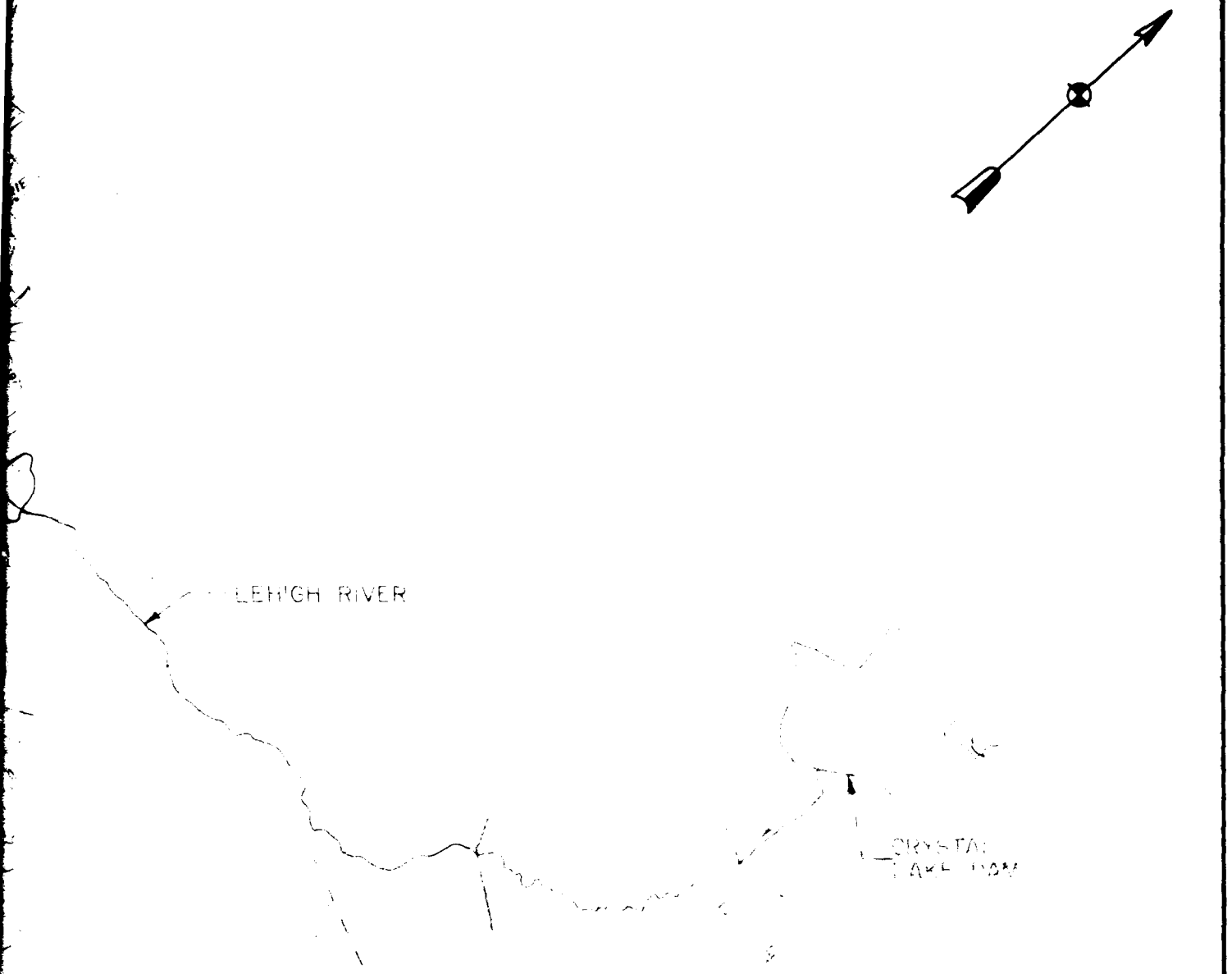


NOTES:

1. LIMITS OF DOWNSTREAM FLOODING ARE ESTIMATES BASED ON VISUAL OBSERVATIONS.
2. CIRCLED NUMBERS INDICATE STATIONS USED IN COMPUTER ANALYSIS.
3. THIS MAP SHOULD NOT BE USED IN CONNECTION WITH THE EMERGENCY OPERATION AND WARNING PLAN.

2000

SC



2000 0 2000

SCALE: 1 IN. = 2000 FT.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE LEHIGH DAM

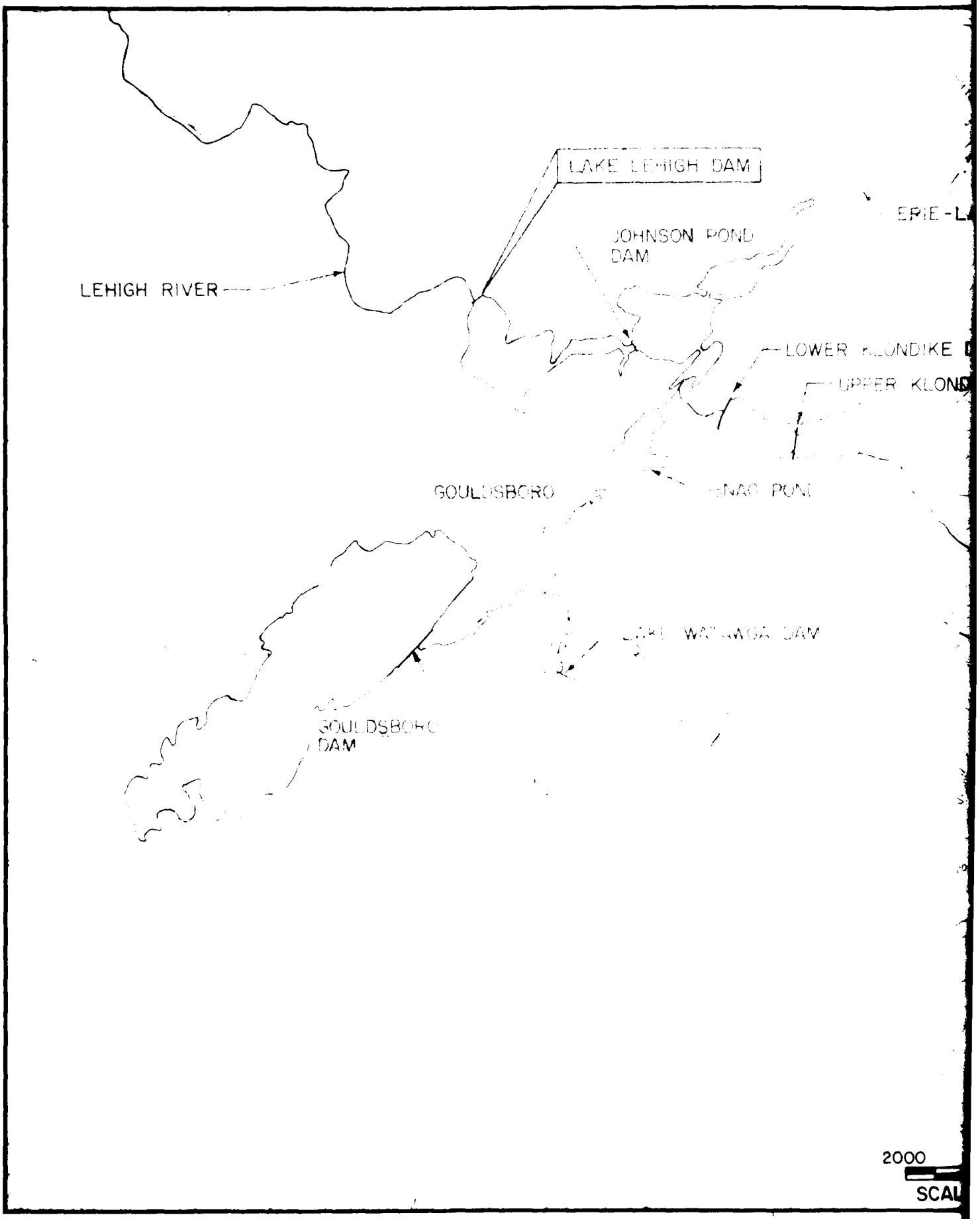
D. M. BRANDON, D. C BRANDON
AND D. L. BRANDON

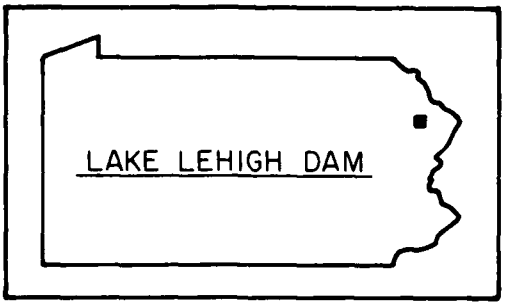
DOWNSTREAM
DEVELOPMENT PLAN

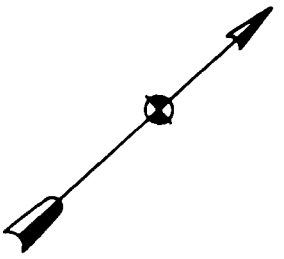
JANUARY 1981 EXHIBIT D-1

APPENDIX E

PLATES


LAKE LEHIGH DAM
JOHNSON POND DAM
LEHIGH RIVER
LOWER KLONDIKE
GOULDSBORO
DAM
2000





ERIE-LACKAWANNA R. R.

7 1/2 MINUTE QUADRANGLES:
TOBYHANNA, PA.
STERLING, PA.

ER KLONDIKE DAM

UPPER KLONDIKE DAM

LEHIGH RIVER

L-CRYSTAL LAKE DAM

2000 0 2000
SCALE: 1 IN. = 2000 FT.

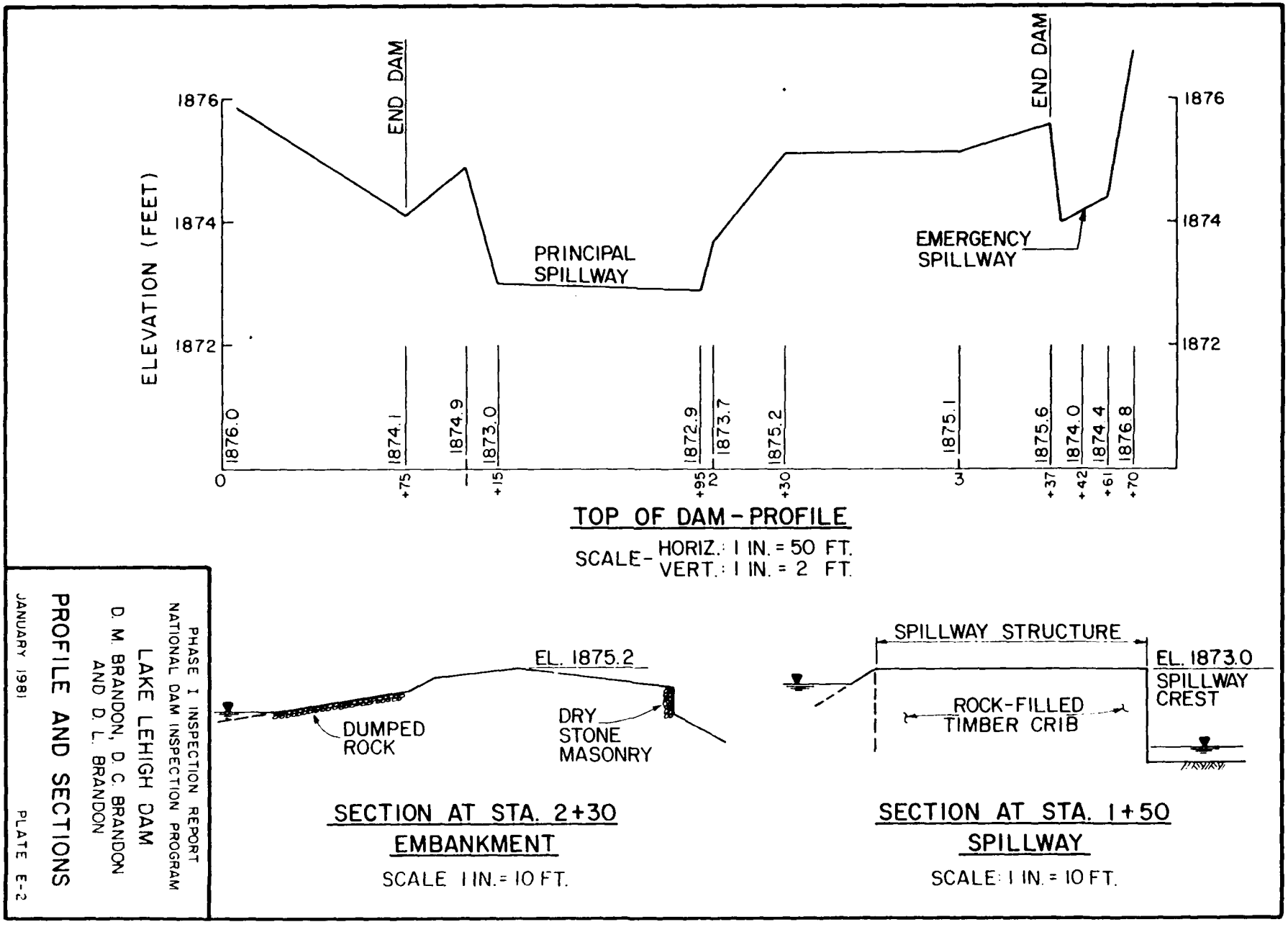
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE LEHIGH DAM

D. M BRANDON, D. C BRANDON
AND D. L BRANDON

LOCATION MAP

JANUARY 1981 PLATE E-1



TOP OF DAM - PROFILE

SCALE - HORIZ.: 1 IN. = 50 FT.
VERT.: 1 IN. = 2 FT.

SECTION AT STA. 2+30
EMBANKMENT

SCALE 1 IN. = 10 FT.

SECTION AT STA. 1+50
SPILLWAY

SCALE: 1 IN. = 10 FT.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE LEHIGH DAM

D. M. BRANDON, D. C. BRANDON
AND D. L. BRANDON

PROFILE AND SECTIONS

JANUARY 1981

PLATE E-2

APPENDIX F

GEOLOGY

LAKE LEHIGH DAM

APPENDIX F

GEOLOGY

Lake Lehigh Dam is located in Wayne County within the Appalachian Plateau Physiographic Province. The most pronounced topographic feature in the area is Camelback Mountain, which is part of the Pocono Plateau Escarpment. This escarpment has a well-defined southwestward trend from Camelback Mountain, but is irregular between Camelback Mountain and Mt. Pocono, which lies to the north. Streams east of the escarpment drain directly to the Delaware River, while those to the west drain to the Lehigh River.

The Pocono Plateau Section lies to the west of the escarpment. This area is relatively flat, with local relief seldom exceeding 100 feet. The topography has been greatly influenced by continental glaciation. Many features were created by deposition of glacial materials. The entire plateau lacks well-developed drainage.

East of the escarpment is the Glaciated Low Plateaus Section of the province. This area is characterized by pre-glacial erosional topography with locally thick glacial deposits. Local relief is generally 100 to 300 feet.

Bedrock units of the sections described above are the lithified sediments of offshore marine, marginal marine, deltaic and fluvial environments associated with the Devonian Period. These units include siltstones of the Mahantango Formation, siltstones and shales of the Trimmers Rock Formation, and seven mapped members of the Catskill Formation. These members include sandstones, siltstones, and shales of the Towamensing Member; sandstone, siltstone and shales of the Walcksville Member; sandstones, siltstones, and shale of the Beaverdam Run Member; sandstone and shale of the Long Run Member; sandstones and conglomerates in the Packerton Member; sandstone and some conglomerates in the Poplar Gap Member; and sandstones and conglomerates in the Duncannon Member.

Lake Lehigh Dam is underlain by the Duncannon Member of the Catskill Formation. The Duncannon Member is predominantly a conglomerate and sandstone unit with some red siltstone and shale. Conglomerates present are generally thick-bedded with subangular to well-rounded quartz pebbles in a coarse-grained sandstone matrix. They are very well-indurated and have low porosity due to silica cementation. The sandstones are predominantly fine-to medium-grained, thin- to thick-bedded and

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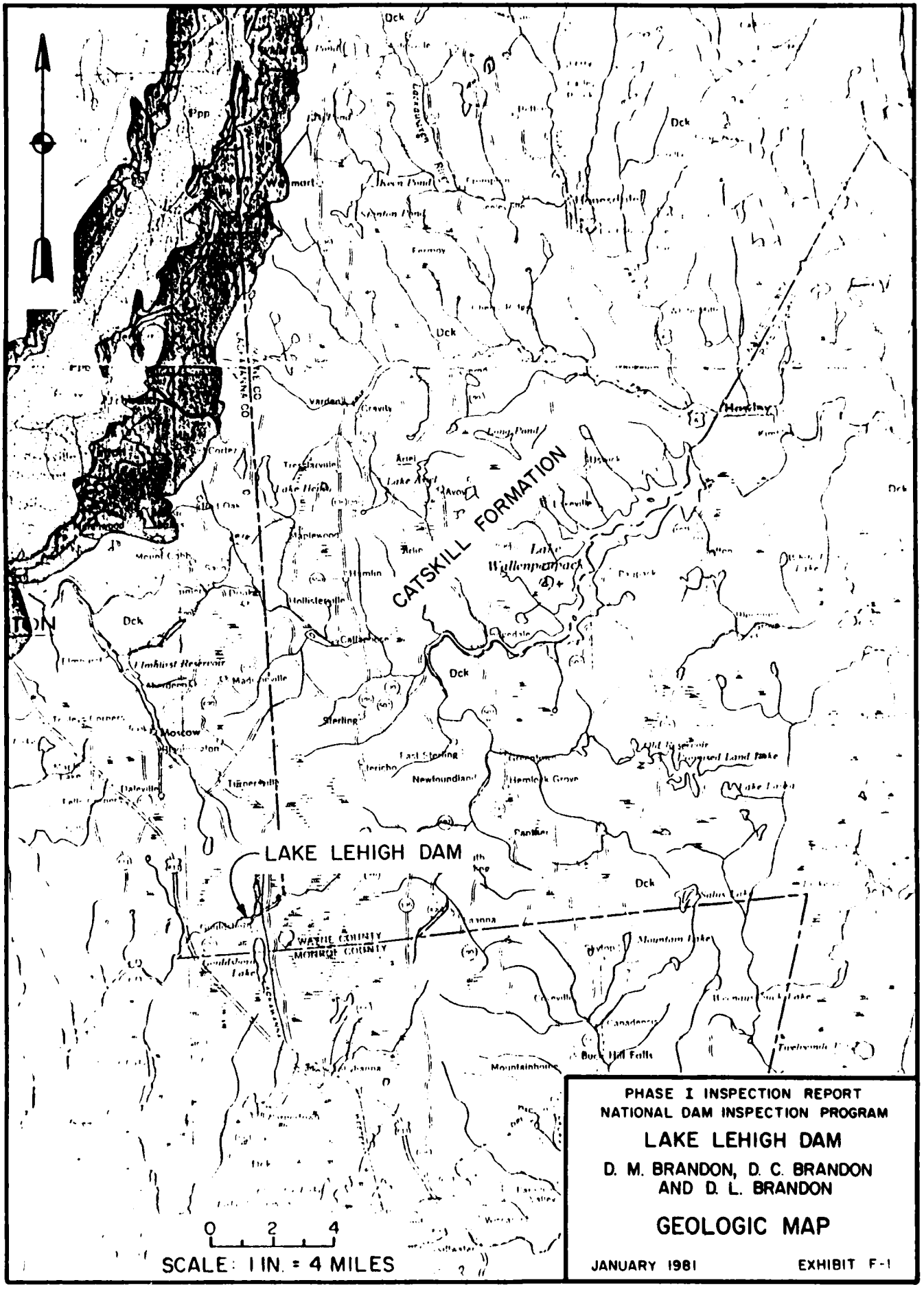
JAN 81 DACW31-81-C-0018

UNCLASSIFIED NL

2 OF 2
AD A 097777

well-indurated with a clay and silica cement. Red sandstones near the top of the unit grade into red siltstone and shale, marking the content with the Brechty Kopf Formation. The Duncannon Member maintains very steep cut slopes and is reported to be an excellent foundation for heavy structures.

Bedrock is almost entirely overlain by glacial till of Late Wisconsin Age. This till is basically an unsorted mixture of clay, silt, sand, and gravel. It is moderately cohesive and is generally derived locally from the sandstones of the Catskill Formation. Thickness of the till varies from 3 to 100 feet, with an average thickness of 45 feet. Available information indicates that the dam is probably founded on this till.



PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

LAKE LEHIGH DAM

D. M. BRANDON, D. C. BRANDON
AND D. L. BRANDON

GEOLOGIC MAP

JANUARY 1981 EXHIBIT F-1


DAT
FILM